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THE LIFE OF ALFRED NOBEL

BY

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FOREWORD

BY

DR. GUSTAV STRESEMANN*

IN Alfred Nobel knowledge of the ever-increasing horrors of War was associated, strangely, but doubtless as a subjective necessity, with a striving after the ideal of International Peace.

He wanted the forces of Nature his own inventive genius had unchained to be curbed by the restraining power of the human soul.

But he knew, and said as much, that Peace would never be secured by merely wishing for it. Arbitration, a united International front against any breaker of the Peace, material assistance and vigilant support for Peace efforts throughout the World, were the means through which Alfred Nobel visualised a possible achievement of his ideal.

And thus it was that almost forty years ago he foreshadowed the way the Nations are following to-day after the terrible experience of the World War.

I hope that this biography of Alfred Nobel will be widely read: for it clearly shows that a man leading a busy life, and one richly crowned with success, can at the same time be a champion of the great idea of World-Peace.

GUSTAV STRESEMANN.

*The late Dr. Gustav Stresemann, Foreign Minister of Germany, shared the Nobel Peace Prize for 1926 equally with Mons. Aristide Briand, the French Foreign Minister.

FOREWORD

BY

SIR AUSTEN CHAMBERLAIN*

I CAN imagine no better introduction to English readers of this Life of Alfred Nobel than the short preface written by Dr. Stresemann, but it is thought that to the English edition a few words by an Englishman should be added.

Since that preface was written, Dr. Stresemann himself has passed away, but not before he had made an immense individual contribution to the cause of international peace.

In the life and work of Nobel and Stresemann we may find encouragement to pursue the ideal which the former conceived and the latter helped to realise.

AUSTEN CHAMBERLAIN.

October 26th, 1929.

*The Rt. Hon. Sir Austen Chamberlain, K.G., Secretary of State for Foreign Affairs, shared the Nobel Peace Prize for 1925 equally with General Dawes, Vice-President of the United States of America.

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INTRODUCTION

THE name Nobel is not a common name in Sweden; anybody ignorant of the history of the family might imagine that they were descended from German or English emigrants; but this is not the case. The Nobels are of old Swedish peasant stock, and they acquired the name in a perfectly natural way. In early times family names were unknown, even amongst the gentry in Sweden; as late as the sixteenth century people were known only by their Christian names, that is, by their own name and that of their father, *e.g.*, Erik Johansson (the father of Gustaf Vasa*). In the seventeenth century the practice of deriving family names from coats of arms became prevalent amongst the gentry (*e.g.*, Oxenstierna, from ox's star). The practice of adopting family names gradually spread to the peasantry, although it was confined to those of the educated class. The first known member of the Nobel family was called Olof; he was a peasant living at Schonen, in one of the four Communes, called Nöbbelöv. His son Per was entered at the university under the name of Petrus Olavi. Both these names were exceedingly common, there being hosts of men bearing the names of Petrus, Olavus, Ericus, etc., and in order to distinguish the bearers of such names, family names were added. These were generally taken from the place of birth, and Petrus Olavi accordingly assumed the name Nobelius, after his native Commune of Nöbbellör. His son and his grandson retained this name, but when the latter entered the army, he dropped the Latin ending, in accordance with military custom, calling himself Nobell. Later on he signed himself Nobel, but the name has always been pronounced Nobell in Sweden.

*King of Sweden 1523-1560 founder of the Vasa dynasty.

To return to the history of the family, Petrus Olavi Nobelius became a student at the University of Upsala in 1682. He had pronounced musical talent, a fact which brought him into touch with that man of genius, Olof Rudbeck, the outstanding personality at the University who laid the foundations of the musical life of Upsala. Rudbeck began as a scientific investigator, and, while still a student, made an important discovery with reference to the circulation of the blood; he then devoted himself to botany and founded the first botanical gardens in Sweden. Finally he lost himself in dreams of Sweden's romantic past, a subject which had a fascination for the Swedes at the time of their country's greatness. His vision of Sweden as the cradle of races and of ancient culture became almost the state religion of the time. In spite of his fantastic imagination, however, Rudbeck had a unique practical genius. He was master of most of the technical sciences of the time, and was a clever architect, while his gifts for organisation were such that he was the controlling spirit of the whole University. In 1696 his daughter Vandela married Petrus Olavi Nobelius, and it would appear that Olof Rudbeck's talents were transmitted to their descendants, since they combined proficiency in the sciences with powerful imaginative gifts, this being particularly true of Alfred Nobel, the most famous member of the family.

The earlier generations of the family were comparatively obscure. Olof Rudbeck's musical son-in-law became a judge, and died in 1707. His son Olof chose a different career; he became an artist, a painter of miniatures, married, and had several children. When he died, therefore, in 1760, the family was not particularly well off. His youngest son, Immanuel, was only three years old at the time. He took up medicine, and would seem to have had real gifts in that direction, but he had not enough money to complete his studies, and was compelled to become a non-commissioned officer in the Uppland regiment. He changed his name to Nobell.

In 1788 war broke out with Russia; the army at the time was exceedingly short of doctors, and men who had had any medical training were made regimental surgeons. On the conclusion of hostilities Nobell continued to practise as a surgeon, but he always appears to have been in straitened circumstances. He did not die until 1839. The history of the family really begins with his son, who was born in 1801 and was also called Immanuel.

NOBEL

CHAPTER I

IMMANUEL NOBEL JUNIOR

IT is clear that Immanuel Nobel was born in an exceedingly poor home. This natural genius never enjoyed any education in the ordinary sense of the word. His handwriting is exceedingly unformed, his spelling erratic, and his capacity to form a sentence exceedingly limited. He went to school only for a short time, and was sent to sea as soon as he was fourteen. It is possible that this calling was chosen for him because his grandfather on his mother's side was a seaman. The following entry appears in the Seamen's Registry at Gävle: "In 1815 the entry of the youth Immanuel Nobel in the Seamen's Registry was authorised. He was born at Gävle on the 24th March, 1800*. Father, regimental surgeon, Emanuel Nobel; mother, Brita Catarina Ahlberg. Unmarried, enlisted by Captain Svedman as cabin boy for Mediterranean service." Captain Svedman's ship was called *Thetis*; the cabin boy's pay was four reichsthaler a month. The voyage was rather protracted, and a further entry shows that Nobel served for three years, one month and ten days. He was therefore home again in 1818. He seems to have suffered some hardships; several of the ship's company, including the captain, died.

Nobel appears to have lost his taste for the sea after his sufferings on this voyage, but there is no evidence as to what his occupation was after his return home.

* For some reason or other he is made out to be exactly a year older than he actually was.

According to the *Gävle Weekly* the *Thetis* returned home shortly before the 25th July, 1818. The vessel, which was now under the command of P. Hamstrand, came from the Mediterranean with a cargo of French salt. Immediately afterwards we find an insertion in the same paper by an anonymous youth aged seventeen, who describes himself as able to write and having a slight knowledge of accounts, and as seeking a position, preferably connected with shipping. Since the age and qualifications tally with those of Nobel, we may conclude that he inserted the advertisement. Presumably he obtained employment in his native town; at any rate, according to the church register, he remained there until 1819.

Biographical accounts generally state that he became a student of architecture in 1818, and a student at the Academy of the Liberal Arts in 1819. It is possible that immediately after his return from the voyage he obtained a position with an architect, and this may be meant by the statement that in 1818 he became an "architect élève." Such an occupation would also explain why he entered the School of Architecture at the Academy. The Academy had two schools of architecture, one for beginners (Principskola) and a "Higher School of Architecture" which Nobel certainly attended in 1821, for he received the Academy's prize for architectural drawings at the prize-giving which took place on the 21st January, 1822. As he naturally could not have entered the higher school straight away, it is exceedingly probable that he began in the Principskola in 1819. He remained at the Academy for several years, and on the 25th January, 1824, the "élève, Immanuel Nobel," was awarded the fourth, or small medal of the Academy, and in the following year, the third, or Tessinska medal. He was not present at the prize-giving of 1826, at which one prize only was awarded, and it may therefore be inferred that 1824 was his last year at the Academy.

The work at the Academy cannot have been very strenuous, since in the Beginners' School classes were held only on Mondays and Tuesdays from ten to twelve, and in the Higher School on Wednesdays and Thursdays at the same time. We may assume that Nobel found some other occupation.

Architecture was, however, not the only subject in which Nobel was being instructed. In 1798 a School of Engineering was established at the Academy of Arts. The idea that an architect should not merely be able to draw, but should also possess all kinds of technical knowledge, was perfectly sound, but it was not realised that a student cannot embark upon the various branches of mechanical science unless he has acquired a grounding in the necessary preliminary subjects. The result was that the School of Engineering proved a complete fiasco.

There were three masters at the school. One of them was required in the course of *one* hour a week to give instruction in the fundamental principles of statics, mechanics, hydrostatics, hydraulics, etc., and at the same time to deal with the weight and mass of the various materials, stress and elasticity, the construction of arches, the comparative strength of flying buttresses, as well as everything appertaining to foundations, the laws of water pressure, the construction of dams, aqueducts, etc.

It was the duty of another master to deal with the so-called alphabet of mechanics, with the laws of motion and the principles governing the simplest forms of lever, etc., as well as to give instruction in architecture and drawing. The third master was required to instruct the students in drawing machines, as well as in surveying. Since, however, as one of the masters observed, the pupils could not understand the lectures unless they had "mastered the necessary elements of geometry, trigonometry and algebra," the number of pupils fell to two at the end of the first year. In 1805 the Principal of the Academy wrote: "The School

of Engineering is at a complete standstill. They are still without their director, who has been abroad for nearly two years; one of their masters has been absent, another has been constantly ill, and the house in which the classes were to be held is not completed."

The school seems to have recovered later, and the reports of 1821 showed that Nobel was one of the most industrious and efficient of the students. The very next year he won the school's largest scholarship of sixty reichsthaler for his "model of a pump driven by wind." The next year the director, Frederik Blom, one of the most popular architects in Stockholm, concluded his list with the following remarks: "Of the pupils enumerated above, only four, namely Nobel, Hallin, Burman and Bergenstedt, have sent in work that is worth showing to the Royal Academy. The others are, for the most part, beginners, whose talents still have to be developed." In his report for the following year, dated the 22nd January, 1824, Blom made a similar remark: "Only two of the pupils mentioned above, namely Nobel and Stahl, have sent in work worthy of recognition. Nobel has sent in a model and Stahl a drawing." He again received the big scholarship of sixty reichsthaler (£3 6s.) "for a well-constructed model of a movable house." He received the same reward at the prize distribution of 1825, "for models of a spiral staircase, two movable houses, and for designs for various calico printing machines, etc." He was still a pupil in 1825, but after that year he disappears from the reports, and in 1826 the School of Engineering was absorbed by the newly-founded Technical Institute. With that institution Nobel was connected for a few months only, in 1826, as teacher in designing, and the statement of several biographers that in 1827 he was appointed master of applied geometry and technical designing at the Institute is not quite correct.

He can scarcely have had an opportunity of acquiring a basis

of theoretic knowledge, but he was a natural genius and had inherited Olof Rudbeck's outstanding practical gifts. In 1826 he seems to have regarded his period of training as ended, and soon afterwards, in 1828, he entered the field as an inventor, and applied for no less than three patents on the 24th March of that year. The first application was in respect of "a planing machine, of which I am the inventor, which has quite exceptional advantages, both as regards quality of work and saving of time. Since there is to my knowledge no other machine whatever that answers this purpose, any further specification would appear to be unnecessary." His other two inventions were "a rolling press with ten rollers, and a mechanical device." The applications were referred to the Technical Institute, which treated Nobel's plane somewhat contemptuously, showing that there already were several similar instruments in existence, but supported the two other applications, especially "Nobel's mechanical device, the object of which is to convert a rotary movement into a reciprocal movement, and that, not by means of cogs, but by a belt. . . . The invention," the report continued, "constitutes as far as the Institute is aware, an entirely novel and original improvement. . . ."

But Nobel had no luck. The Board of Trade* turned down his application in respect of the plane, and as far as the other two patents were concerned, the Board of Trade appears to have forgotten all about the matter, for no decision was taken and no resolution was passed.

At this time, in spite of his lack of theoretical training, Nobel was making a position for himself as an architect and engineer.

In 1827 he married Andrietta Ahlsell, daughter of a head clerk, and the marriage was extraordinarily happy. The life

* The Royal Swedish Board of Trade (Commerce Collegium) acted also as Patent Office until 1891, when a special Patent Office was created.

partner whom he had chosen combined the best qualities of head and heart; she was a simple woman, good and wise, and her letters proved that she had much humour. Her children did not merely honour her, they almost adored her.

Andrietta Nobel had need of her equable disposition, for the young couple found it difficult to make both ends meet, and in January, 1833, Nobel was compelled to file a petition in bankruptcy. The papers about this give considerable information regarding his life and activities during these years. On the 1st October, 1828 he had rented an apartment in a suburb of Stockholm, called Staerkalsebruk. The ground floor consisted of a room and kitchen, and the upper floor of a kitchen and two rooms, the rent being 106 reichsthaler, 32 shillings per annum. This rent seems to have been Nobel's main difficulty. The furniture was very simple, consisting of a double bed, a writing table, four plain tables, a drawing table, an upholstered sofa, a dozen or so rather shabby chairs, two tea tables, iron and copper worth about twenty reichsthaler, two mattresses and pillows, two blankets, six pairs of sheets, three pillow-cases, glass and china worth ten reichsthaler. The record of the proceedings reveals Nobel's industry as well as his spartan simplicity. He was engaged on a number of orders; he was building a house at Stortorget for Anjou, the court official, and at Munkbron for a nobleman called Petersén; he was engaged on a laundry near Jacobsberg and a suspension bridge at Skurusund. The latter order was worth nearly the considerable sum of thirteen thousand reichsthaler. At the same time he had suffered a long series of reverses, and he himself estimated in a statement attached to his petition the losses from these at 15,471 reichsthaler and 32 shillings. His most serious loss arose from the fact that the property of Knaperstad at Langholmen was burnt down. His liabilities amounted to only 11,698 reichsthaler, 10 shillings, and as his assets were estimated at 5,129 reichsthaler, 16 shillings, he

would have had a substantial surplus but for this fire. In the actual circumstances there was no alternative but for him to go bankrupt in 1833. The bankruptcy was not made effective until July, 1834, but it did not liberate him from his debts. In 1837 one of his unsatisfied creditors threatened him with prison, and he was not entirely free of debt even by 1850, although by that time he had paid off most of his old creditors. In the end they all got their due, and it would appear that Nobel did not allow reverses to affect him. To an increasing degree he directed his energies to inventions of the most varied type, and although he had never really studied chemistry, he plunged into chemical experiments. He bought a small rubber factory, and installed apparatus for chemical, military and industrial purposes. He seems to have been particularly interested in the idea of a kind of sack or pack in which the soldier could carry his kit, but which should also be capable of being expanded into air cushions on a bridge of which the troops could walk when they wanted to cross a stream. As, however, in spite of all his efforts, he found it difficult to make his way in his own country, he decided in 1837 to emigrate to Finland. The passport in favour of " I. Nobell, mechanic," was issued on the 15th December. The documents available do not show how long he stayed in Finland; but it would appear to have been for a short time only. He eventually settled down at Petersburg, and his family followed him there in 1842. On the 21st October the passport in favour of his wife " and two infant children " was issued. These were probably Ludwig and Alfred, who were eleven and nine years old at the time.

It may be natural to wonder what compelling motive, apart from his economic difficulties, could have induced Nobel to leave his country and, for a time at any rate, his family, in order to try his fortune in Russia, a country with which he was wholly unfamiliar. We may also wonder how he came to devote inventive

talent and his energies generally to the development of military technique, although he had never previously taken any interest in that subject. The fact that he selected this sphere of activity was to be of decisive importance, not only to himself, but also in determining the life work of his sons.

When one considers the conditions obtaining at the time, it will be readily understood that Nobel considered the outlook in industry and applied science as exceedingly unpromising in Sweden. It was a comparatively short time since the country had been through a serious war and had experienced profound political and economic crises. There was a general shortage of capital, and industrial enterprise was hampered. The only important branch of industry with a really old tradition which had reached a comparatively high stage of technical development at the period under discussion was mining and its associated activities. This was, however, an entirely foreign field to Immanuel Nobel; moreover, mechanical development had barely begun. According to the annual reports on industry itself, apart from mining, which the Board of Trade began to publish in 1830, there were in that year altogether 1,857 manufactories, employing about 12,000 hands, and with an annual output of the value of something under £5,000,000. The most important groups were made up of textile factories and dye works, as well as sugar, tobacco and paper factories, the total value of whose products amounted to four-fifths of the whole amount. There were no real factories in our sense of the word; other trades were generally carried on entirely by hand labour. It is obvious that in such circumstances the prospects for an inventor, especially in the field of mechanics, which was Nobel's strong side, must have been very poor. It is only natural that when he got to Russia he should have devoted himself to such inventions and technical processes as would be of use in connection with the requirements of the state. There is no doubt that at that

time Russia was at an even lower stage of industrial development than Sweden. The authorities seem to have lacked any sense of the importance of the development of industry at home. Their attitude was quite different where there was any possibility of an improvement in the measures for home defence, with a view to strengthening the uncertain political situation of Russia. The relations between that country and the Western Powers, England and France, were strained, so that she would naturally welcome any device that would increase her sense of security. It is therefore not surprising that, having regard to his circumstances at the time, that Immanuel Nobel should exploit the possibilities offered by his inventive gifts.

Nobel constructed various machines at Petersburg, amongst which his appliance for cutting wheel-naves is particularly well known. He devoted himself especially to the construction of mines, and devised mines for defensive purposes at sea and on land. In the course of these experiments he made the acquaintance of a Russian general and engineer who was exceedingly interested in his discoveries, and sent in certain reports about them to the Minister for War. These reports have been preserved in translation amongst Nobel's papers in Stockholm, but unfortunately without the name of the signatory,* and since they give the most reliable information regarding Nobel's activities in the forties, we quote them below. They are amongst the few documents of that period that have been preserved, since during the recent Russian Revolution the whole of the Nobel archives at Petersburg were destroyed, and any papers that may remain are not accessible at the present time.

"To the Minister for War.

"Your Excellency has informed me in the communication dated

* According to the statement of Dr. Emanuel Nobel, the officer in question was General Egareff, who later became Nobel's partner.

the 19th September, 1841, No. 597, of His Majesty's command that the foreigner Nobel shall be permitted to carry out experiments in the methods he has discovered for destroying the enemy at a considerable distance.

"Since then Nobel has been constantly occupied with the preparations for these experiments, although he has been delayed from bringing them to a conclusion by various causes, the chief of which has been the fact that he himself has undertaken to devise permanent sea-mines, in which matter he has now attained exceedingly satisfactory results.

"Moreover, at the end of 1844 Nobel carried out in my presence an experiment of blowing into the air a portion of land, by means of a powder apparatus, which experiment proved perfectly successful.

"This system deserves special attention, in view of the simplicity of the mechanism, as far as one can judge from a superficial impression. A sapper unit could lay the mines in an allotted section in a very short space of time, and an enemy attempting to take up his position there would be threatened with annihilation. These methods could be applied with particular advantage in the following cases:

"1. In defiles, if the rearguard covering a retreat is hard pressed by the enemy.

"2. In villages which have to be abandoned to the enemy, and through which it is essential for his artillery to pass.

"3. In order to keep the enemy at such distance as may be judged necessary from the approach to a bridge.

"4. To strengthen the defences of a fortified position, when such position has been chosen pre-eminently on strategic grounds, and offers no difficulties to hostile attacks.

"5. For defence against unexpected attacks upon isolated fortified positions, as, for instance, on the East Coast of the Black Sea, and in similar places.

"6. In order to surround with such mines a position that must be held at all costs; in such a case two or three rows of mines can be laid upon one another, in order to deal with successive enemy attacks.

"In my communication of the 16th September, 1841, No. 2803, I informed Your Excellency that Nobel wished to receive a gratuity of 40,000 silver roubles if his device were accepted. Although in order to achieve the results which are the fruit of his experiments, he has not merely had to expend considerable time and energy, but has also not infrequently risked his life in handling the various apparatus, since he will not entrust them to anyone else, and although he therefore feels that his experiments deserve to be recognised in the manner indicated, he is prepared for the time being to forego this reward, as he apparently does not consider himself justified in claiming it in view of the fact that the only experiment that he has carried out may be inadequate to convince the Government of the real value of this discovery, and he asked only to be granted a one and final indemnity of 3,000 silver roubles for the expenses which he has been compelled to incur in order to acquire a piece of land, in making his materials, in hiring labour, and generally to cover the expenses of the preliminary mechanical work on his undertakings, in as far as they exceed the amount originally granted to him for carrying out his experiment.

"I consider Nobel's request to be entirely justified by the facts, and as the experiment which he carried out in my presence confirmed me in my belief in his statement regarding the trouble and expense to which he has been put over a period of three years, I would respectively request Your Excellency, when reporting to His Imperial Majesty, to recommend to His Majesty that Nobel be paid the amount he asks.

"I feel that I should add that Nobel receives no honorarium

from the committee for experiments under water, and that he therefore finds himself compelled to ask for compensation for the time and expenses which that work requires him to withdraw from his other occupations."

"To the Minister for War.

"Your Excellency was good enough to inform me in your communication No. 112, of the 5th March, 1842, that His Imperial Majesty had been graciously pleased to permit the carrying out of the experiments proposed by the foreigner Nobel with moored and drifting mines, in accordance with the request which I asked you to submit to His Imperial Majesty.

"I may perhaps assume that Nobel's moored mines, with which Your Excellency is already familiar, have been accepted, and that we have only to wait for them to be put into practical use, and I therefore have the honour to transmit to you the communication which I have received from Nobel, regarding his proposed experiments with drifting mines, and would repectfully request Your Excellency to be good enough to submit them to the gracious consideration of His Majesty, and to inform me how far His Majesty the Emperor may be graciously pleased to permit that experiments should now be made with these mines, and that Nobel should be paid the three thousand silver roubles which he requests for this purpose. In this connection I consider it my duty to observe that the success which has hitherto attended all Nobel's experiments and his proved talent for inventions of this kind, constitute a guarantee for the reliability of his representations with regard to these proposals too; if the invention should be successful, the consequences might be so important that, in my view, the inconsiderable sum named for the experiment is negligible."

There are two interesting pictures of these experiments, one showing a landmine exploding near Petersburg, and the other a seamine exploding in the river Ochta in the year 1852. In spite of the success of these experiments, it would appear that the mines were not adopted by the Russian Fleet because the departments could not agree whether sea mines came into the province of the Admiralty or not, so that the whole question was shelved indefinitely. The outbreak of the Crimean War in 1854 brought it to the fore again, but the mines manufactured by Russians soon proved to be worthless, and the High Command, passing over the Russian Corps of Engineers, entrusted the mine-laying programme to Immanuel Nobel's eldest son, Robert, to be carried out in accordance with his father's scheme. Robert executed his task so efficiently that the British Fleet did not venture within Finnish waters. As stated in a biography of I. Nobel, " it is certain that no enemy vessel could have been sunk or destroyed by these mines ; but a small mine that had been taken out of the water was brought on board the Flagship *Duke of Wellington*, where it was subjected to such close examination that it exploded and killed one man, a fact which filled the English with deep respect for these little objects. Their attitude was confirmed by the fact that the captain of a Russian steamer, who obstinately insisted on breaking through the line of mines, refusing to use the passage of which he had been told, suffered severe damage to his ship from a mine. In spite of this grave breach of duty, he was not severely punished, since the explosion occurred close to the English squadron lying off Sveaborg, and they were duly impressed by the effectiveness of the mines."

Immanuel Nobel produced a magnificent work on the system of mines which he had invented : *Systeme de défense maritime pour passages et ports sans fortifications dispendieuses et avec épargne d'hommes, par Im. Nobel.* The work, which is in manuscript,

with coloured illustrations, is in the possession of Ludwig Nobel, a son of Robert Nobel.

Thanks to the financial assistance which Nobel received for his inventions from the Russian Government, at the beginning of the 'forties, he was enabled in 1842 to set up a workshop and foundry, which was so successful that in a short time he was considered to be one of the most competent engineers in Russia. The factory became more and more important and in 1848 he wrote to his friend and brother-in-law, Ludwig Ahlsell: "Everything is proceeding here according to plan; I am up to the eyes in work, and am constantly having bother with my unruly crew, who want to get all they can, and do as little work as possible for it. I was ill all through Christmas, and then, when I came down to the works to pay out the monthly wages, 21,000 roubles, I could scarcely see a sign of any work having been done." Nobel's business now got under way; he paid his old debts, and a letter to his brother-in-law shows how much sympathetic assistance he gave to all his old friends and relations in Sweden. "If my sons," he wrote to Ahlsell, "work harmoniously, and carry on the work that I have begun, I believe that, with God's help, they will never want for their daily bread, for there is still much to be done here in Russia. Although I am old, I myself hope that if things go well I shall be able, in a few years, to free you, who have done so much for me, from your debts, if you should then still have any debts or worries."

During these years one invention and improvement succeeded another. He invented machines for the manufacture of wooden wheels, "and although," as we read in an anonymous manuscript biography, apparently the work of one of Nobel's employees, "the invention was not very paying itself, and had to be given up later, the Government appreciated the new method, and ordered two sets of these machines for its arsenals. He also invented a new

system for heating dwelling-houses with hot water, conducted through pipes, after being heated in a single boiler. He made the first experiment in his own house, but the invention was soon afterwards applied in hotels, hospitals and important private houses." The manufacture of machines was meanwhile being carried out under very unfavourable conditions. In order to protect the Siberian ironworks, raw materials were subject to very heavy duty, although Finnish machines could be imported free of duty. The Nobel factories therefore relied principally upon orders from the Government; these were certainly fairly substantial, partly because the Russians now realised the necessity for replacing their old sailing fleet by steamships. "Nobel's development as a manufacturer after the outbreak of war in 1854," this biographer continues, "is exceedingly interesting, both on account of the considerable achievements of this time and on account of the difficulties with which he had to contend. The war had brought the iron hammers to a standstill, and it was impossible to import raw material or machinery from abroad. There were no resources worth mentioning in the country, but he was required to build five hundred horse-power machines. Three of them were built after English designs, it is true, but with his own materials. The great shafts were forged with hammers constructed in the works themselves. The great cylinders were moulded and drilled by machines specially made for the purpose. At the same time five propeller machines, of two hundred horse-power capacity each, were constructed. These were made under pressure of time, according to his own design." In a book on the Nobel factories, written in Russian, we read the following statement: "During the second year of the war, Nobel got an order for ship's engines from the Government. This order was an exceedingly difficult one to carry out, as there were no skilled workmen and no technical experts available. The fact that the order was carried out was due

to the energy and industry shown by Nobel and his sons. The engines which they built for the Russian fleet constituted an important element in Russia's maritime defences of that time, and they were very highly appreciated. The first of these powerful engines were constructed in Petersburg. The ships *Vola* and *Gangud* sailed in the Baltic, and the gunboat *Rättvisan*, a two-decker carrying eighty-four guns, inspired respect for the Russian fleet in the Mediterranean. Meanwhile it proved to be necessary to apply every effort to build a still larger navy of steamships if possible. N. J. Putiloff, a well-known shipbuilder of the time, got the order from the Government to build a hundred gunboats, fourteen corvettes and six cruisers. Nobel and his sons proved experienced and energetic collaborators, and with their assistance the engines and guns for three corvettes were completed within a year. Nobel's workshops produced altogether eleven engines, with a capacity of two hundred to five hundred horse-power, for the Fleet."

In 1853 Nobel was awarded an Imperial gold medal for his services to Russian industry, a distinction which cannot often have been conferred upon a foreigner.

In order to be able to meet the requirements of the Government, Nobel constructed new works with his own and borrowed money, which are said to have been capable of employing over a thousand workmen. He had the written undertaking of the Government that he should always get orders in the future, if he would undertake the deliveries that were urgently required during the war. But the Emperor Nicholas died, peace was concluded, and the new Government simply disregarded the promises made by its predecessor. It reverted to the old system of placing orders abroad, and Nobel's factory was left to its fate. In April, 1857, he wrote to Ahlsell: "You commiserate with me in my losses through the fire; but considerable though these losses were, they are only a

drop in the ocean compared to those that I have suffered through the fact that the Government has broken its promises, and refuses to recognise its engagements, now that the war has ended. This blow nearly knocked out of me the little vitality that I still possessed, and for three months after I fully realised the position I was completely bowled over. By now, however, I am, thank God, sufficiently recovered to be able to work and think. As you will remember, I once said, when we were discussing my position, that if the Government, in accordance with its written and printed statements, kept my large factory busy, which was built as the result of its promises, I would be in a good position; that otherwise I would have nothing, since I had put my all into this great undertaking." His claims for compensation were disregarded, and Nobel was again a ruined man. In 1859 he was forced to surrender the factories to his creditors, whereupon he returned to Sweden to try his fortune in his old home.

To start afresh at the age of almost sixty, without any means, is not an easy matter. Nothing is known of Nobel's activities immediately after his return, and it is doubtful whether he went straight to Stockholm in 1859; but the tax returns of November, 1861, in respect of the year 1862, show that he rented the property of Heleneborg, probably as from the 1st October. The house was in the same quarter as he had lived in while in Stockholm, and the rent was 775 reichsthaler. Nobel is described in the list of taxpayers as "formerly a merchant," and his family consisted only of himself, his wife and his son, Emil Oskar. The elder sons, Robert, Ludwig and Alfred, did not accompany him to Sweden. Emil was only eighteen in 1861; he was the youngest of the family, two younger children having died in Petersburg. We have no definite information as to how the father of the family got through these years; he had no factory at Heleneborg either in 1862 or in 1863. Towards the end of 1862 his son Robert had come over from

Finland, but only on a visit. Things did not take a turn for the better until 1863, when Alfred came to Stockholm; like his brother before him he stayed with his old parents. It was in that year that Alfred made his first important discovery, of which we shall have more to say later; it was a mixture of gunpowder and nitroglycerine, whereby the explosive power of gunpowder was considerably increased. On the 14th October, 1863, the Board of Trade granted him a ten years' patent "to manufacture this kind of gunpowder." This was followed shortly afterwards by an exceedingly important improvement for which he received a patent on the 15th July, 1864. Then, and not till then, a factory was built at Heleneborg. In 1864 Nobel rented a neighbouring building from the burgomaster, and in this the first experiments were carried out. The new workshop was really a laboratory rather than a factory, the output being quite trivial. Apart from Immanuel and Afred Nobel, the staff consisted only of a single engineer, a boy and a maid, and of Emil Nobel, who had been a student at Upsala since the spring of 1864, and who happened to work in the laboratory during the summer.

On the 3rd September the great tragedy occurred. On that morning the new workshop blew up and destroyed Emil Nobel, Hertzman, the mechanic, the boy, the maid, and a workman who happened to be passing at the time.

This disaster completely broke Nobel; one month later, on the 6th October, he had a stroke from which he never recovered. It is true that his condition improved, but he never regained his former capacity for work. In April, 1865, he was able to write a letter to Alfred in pencil, in which he stated that he believed he felt his power to move his hands and feet was beginning to return, "but before I can walk and move by myself, I shall not venture to think of going to take the waters anywhere, for that is far too expensive." In the same letter his wife wrote to say that he could not stand or

walk, even with assistance : " but the dear old fellow," she added, " is already beginning to have fancies, and this is hardly surprising when you think what a monotonous and wretched life poor papa leads. To lie in bed for four months, and not to be able to make a single movement, even lying down, without help—that is a test for an old man's patience ! " In another letter, written in June, Immanuel Nobel again complained that it took so long to get better : " I still lack the means for carrying out a proper cure."

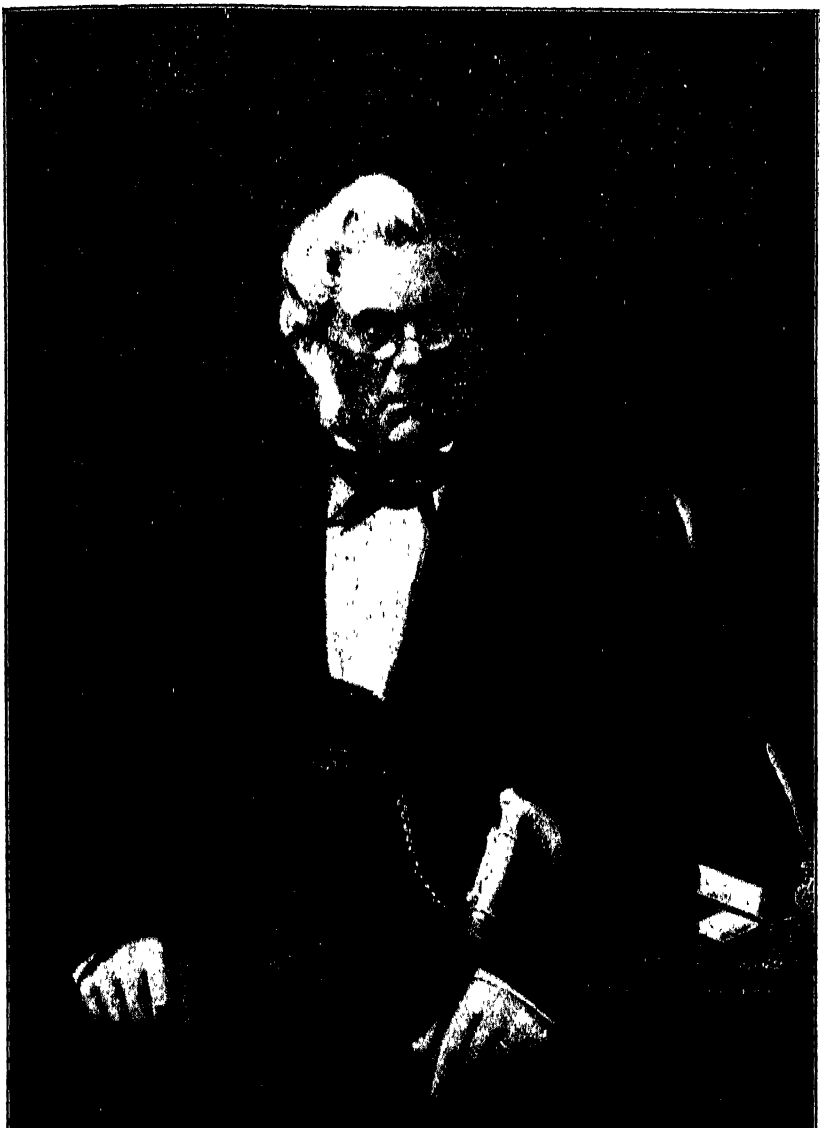
As we shall see, Alfred Nobel himself was going through rather a difficult time just then, but all the same he sent the old people money so that they could travel to Norrtälje.

" After God," his mother wrote to him, " we have to thank my little Alfred that we can be here and take the baths. I am quite sure that we have benefited already. Dear old papa can't take a step out of doors, it is true, but he himself feels that he is stronger, and I feel better too."

Although broken down in health, the old man continued, as his wife wrote, to have fancies and to busy his brain with all kinds of inventions. A year before his death he wrote to Alfred Nobel that he was working at a discovery which would make him " a dictator in matters of peace and war throughout the whole world, for the next few centuries at least." His wife had a clearer perception of the situation. " He is now beginning," she wrote, " to busy himself with all kinds of affairs, and to keep people on the move, but, as it seems to me, all to no effect—it's a natural result of his great activity in the past, which wants to express itself again. It's a long and weary time for the poor old fellow." But even at this time he was not lacking in constructive ideas, and in 1870 he published a thin little book which is highly characteristic of him, both on account of its imaginative foresight and of a certain fancifulness wholly typical of Olof Rudbeck's descendants. The pamphlet is entitled : " An attempt to create a new industry in

order to check the emigration mania resulting from the present lack of employment."

"This is no easy matter," the pamphlet begins, "for it is necessary to find a material that is plentiful and cheap, so that it will be within the range even of persons of moderate means. During the five years since my stroke, in which I have often been in pain, and suffered from sleepless nights, I have succeeded in thinking of the raw material which I am convinced is the most suitable for solving the problem." The raw material which he had in mind was the scrap wood in saw mills. "Such scrap wood," Nobel wrote, "is now being burnt, simply with the object of getting rid of the stuff; but it would furnish a most suitable raw material for home industry, and thousands of unemployed could thereby make a living, especially such seasonal workers as throughout the winter are often on the verge of famine. Apart from home industries, this raw material can be used in the manufacture of large and small wagons, as well as of houses, which would later become valuable exports to warmer countries, especially such as are subject to earthquakes." Nobel particularly had in mind the banks of the Suez Canal, which would have to be developed on the Canal being opened. The description and the specimens of tubes, made according to Nobel's specification, shew that his idea was to produce a kind of composition veneer, from woodshavings or thin cuttings glued together, these being superimposed in such a way that the fibres of the different layers should be interwoven; and also to manufacture various articles by steaming and bending wood. "It is," he continued, "fairly probable that people will be sceptical as to the possibility of manufacturing articles from thin shavings of wood; but these shavings must be produced by specially designed steel instruments, which cut out shavings of the thickness of a line as they plane." Nobel had actually achieved the thickness of a quarter of a line, and he writes: "The shavings from which the



IMMANUEL NOBEL THE YOUNGER

ANDRIETTA NOBEL

articles here shewn were made, have been produced by an ordinary plane which, merely pressing upon the shaving as it does, naturally very much weakens its strength. This will not occur with the method which I shall employ in future for producing shavings. We must also bear in mind that in this way no material is lost, as it is when wood is cut with an ordinary saw, this loss amounting to ten shavings of the thickness of a line for every log cut into boards an inch thick. It is easy to see how much greater use can be made of the same amount of raw material than is the case at present." Nobel appended to his description of the numerous advantages of the new raw material a " list of such articles as can be manufactured out of wood shavings as the basic material, as well as out of ordinary wood adapted by steam to various purposes."

The list constitutes an interesting and amusing example of that mixture of practical foresight with an imagination which occasionally gets out of control, which was not uncommon with Immanuel Nobel. Nobel divided the articles which he desired to produce into six groups, according to their form, and according to whether they would have to be manufactured from angular, circular or oval tubes, out of flat panes, or in moulds specially made for the purpose. The large number of articles which he enumerates constitute the most varied assortment. Many of them are to-day actually manufactured from plywood, while others are simply examples of an imagination which was unable to distinguish between practically realisable ideas and purely bizarre phantasies. Nobel's inventive ideas frequently suffered from this curious lack of judgment, which is often characteristic of inventors of the greatest genius. A similar lack is occasionally noticeable in the case of his son, the world famous inventor of dynamite. Possibly it was a characteristic inherited from Rudbeck, the famous author of " Atlantis " (the cradle of races).

A few examples may suffice of Immanuel Nobel's list of articles

to be manufactured from plywood: "hollow beams, rafters and vertical supports to be used in place of massive beams."

"Rectangular cases and boxes, trunks, hatboxes, cradles and baby carriages. Pipes for the conveyance of water and gas, as well as for sending letters and parcels.

"Pipes for the transport of corpses in coffins from cities to the burial places outside (!)

"Articles for various building purposes, e.g., parquet floors, outside roofs, and double walls with a space in between.

"This material would be specially useful for the construction of movable houses, such as might constitute an important export for Sweden, especially to places which are subject to earthquakes.

"For coffins, which, while combining cheapness and lightness with tasteful construction and the necessary decoration, could be so made that a person coming to life in them could lift the lid from inside, the lid being provided with airholes for breathing, and with a cord attached to a bell (!)

"For light and elegant hampers.

"For safety sledges to be used in crossing thin ice.

"For large and small carriages, etc."

It is a matter of common knowledge how important the industry sketched out by Nobel, namely the manufacture of so-called plywood articles, has become, especially in the United States, in Germany, England and Scandinavia. The new material has been adapted on a large scale to many of the purposes which he proposed, although several of his suggestions have remained impracticable of realisation. Such for instance was the idea of manufacturing "pipes for the transport of corpses from cities to the burial places outside" and the manufacture of "coffins so constructed that a person coming to life in them could lift the lid from the inside, the lid being provided with airholes for breathing, and with a cord

attached to a bell."* Nobel reckoned that this new material would find a market for other purposes besides building, especially in Egypt. "The tubes described in the appendix," he wrote, "would, if properly adapted and produced in large quantities, make it possible, through the cheapness of their manufacture, to convey the water of the Nile below the surface of the ground into the desert, in which case it would not evaporate before reaching its destination. The water flowing through the pipes would prevent them from decaying inside, while the outside could be protected with sand mixed with salt, such as is available locally. The power of the flowing water could be applied to useful purposes." Such extravagant ideas are entirely characteristic of Nobel; and another one is worthy of being recorded. In a letter to Robert Nobel written in 1862, he mentions that he has a scheme for catching and training young seals, which are to be muzzled and tamed in a convenient pond until they answer to their names and eat out of the hand, etc. "If I should require even more from them later on," he wrote, "it would not exceed the capacity of these animals." Nobel had, in earlier days in Russia, with some slight support from the Government, carried out a series of experiments with self-driven mines; the problems which he endeavoured to solve had, however, obviously offered difficulties incapable at the time of a satisfactory solution. He seems at this time to have been speculating upon the possibility of using trained seals as live motors for the mines, for after mentioning that he had finished a treatise on mines, which he was thinking of submitting to King Karl XV, he wrote immediately after the passage quoted above: "My plans with these animals also have something to do with this, if you can get them and train them in the manner indicated, and I shall at once tell you how the matter has gone through and what is to be done." We do not know to what extent this quaint proposal,

* The fear of being buried alive is, oddly enough, sometimes expressed in his son Alfred's letters, and even in his will.

which reminds us of Hannibal's well known experiment of driving herds of cattle against the Romans with burning bundles of rice attached to their horns, ever got beyond the stage of pure conjecture. In 1864 Immanuel Nobel was granted a particularly compendious patent for his mines, valid for a period of fifteen years.

In spite of his fanciful ideas, Nobel was a real genius who, without any actual technical education, became an important inventor through his natural gifts alone. He was rich in ideas, but his lack of education often made itself felt, since he could not always distinguish extravagant ideas from such as were capable of practical application. Moreover, he was no business man, but a confirmed optimist who never reckoned sufficiently with possible difficulties and real obstacles. The hardships of his life were therefore to no small degree a consequence of his own shortcomings; but his character, which is an extremely lovable one, was not affected by them in the least. He had great industry and the work itself interested him more than the reward. Finally, he was a really good man who, when his means allowed, helped others as much as he could. He had experienced much misfortune in his life, but he had borne his misfortunes like a man. He may have found it hardest to bear the decline in his power to work, which afflicted him during his last years, but the bitterness of this blow was lessened by the successes of his sons, thanks to whose achievements he did not die in complete poverty. Alfred had given him thirty one shares in the nitro-glycerine company, of which we shall have more to say. He was forced to sell six of these, but he still held twenty-five at his death, and they generally paid ten per cent dividend. After his death, on the 3rd September, 1872, his estate was valued at 28,701 kronen. The greater part of it consisted in the shares in the nitro-glycerine company, which were worth a thousand kronen each. His personal estate was valued at only 3,575 kronen, and his debts at only 4,204.

His wife died seventeen years later, at the age of eighty-six. She lived as simply as while her husband was alive, but through the efforts of her sons she had become rich, and left property worth over 840,000 kronen, the greater part of which consisted of deposits in no less than ten separate banks. She still possessed the twenty-five shares in the nitro-glycerine company, and these were worth eight times as much as when Immanuel Nobel was alive. The interval between her husband's death and her own covers the great period of her sons as inventors and manufacturers.

A description of Immanuel Nobel's life cannot be more aptly concluded than by quoting the last letter that he wrote to his son Alfred. He could not hold the pen himself: he dictated the letter and endeavoured to sign his name.

"Stockholm and Heleneborg, 26th December, 1871.

"OUR DEAR ALFRED,

"We got your dear telegram just as we were going to drink our morning tea, and our good Liedbeck brought us all your surprise sweets at five o'clock on Christmas Eve, which was enlivened by a visit from old Ahlsell—who had not been to see us since my birthday—to the great joy of your dear good mother, who was particularly pleased because you remembered not only Pauline and the children, but also, to her still greater joy, Lotte Henne and her children.

"I have now almost completed my New Year's gift for the defence of old Mother Svea in her present defenceless condition, and may hand it in as a humble New Year's offering at the beginning of the year.* We shall see what the fellows in the Reichstag say to it. Your old parents send you a hearty embrace as your last in this year, and rejoice that they have such sons, that bring us always happiness and never sorrow."

* Probably a simple kind of machine-gun. Mother Svea is a common synonym for Sweden.

CHAPTER II

ROBERT AND LUDWIG NOBEL

WHEN Immanuel Nobel returned to Sweden in 1859, the close collaboration which had hitherto existed between the various members of the family, was interrupted for a time. The father was accompanied only by the youngest of his sons, Emil, who was born in Petersburg, the three eldest sons remaining in Russia. We must now turn our attention to the two eldest brothers, Robert and Ludwig, who were both seeking to make their way independently. Although they were almost constantly having business dealings with each other, their real co-operation did not begin until 1870, and we shall therefore deal with the life of each of them separately during the 'sixties, and then pass to their later activities.

The sources for Robert Nobel's biography during these years are his account books for 1860 and 1863, and a book of copies of letters starting in 1864. The account book for 1860 shews that he and Alfred were at that time living together in the house of General Müller. The rent was remarkably high, 233 roubles 35 kopeks for four months, but this probably covered both living and office accommodation. The two brothers seem to have led an almost spartan existence, Robert's daily expenditure scarcely ever reaching the amount of one rouble. The same account book shews that Alfred was often ill, for amongst his brother's payments there are several entries for doctors and medicine for him.

The account book gives no direct information as to the

activities of the two brothers, but it would appear that they had a lot to do with their father's former mechanical workshops. At any rate the "Nobel factory" is often mentioned, and there are references to a clerk, Nikolajeff, who appears to have been employed in their office at a monthly salary of ten roubles. Robert seems also to have been employed as an architect, and to have worked, amongst other things, on repairing the Kasan cathedral. Moreover he discovered a deposit of fireproof clay in the neighbourhood of Petersburg, and began to manufacture fireproof bricks, and actually endeavoured to produce objects of Art in terra-cotta. In 1860 he was principally engaged upon the completion or reconstruction of the steamer *Kryloff*, which afterwards made voyages in the neighbourhood of Petersburg. The *Kryloff*, however, does not seem to have been a particularly brilliant success as a ship, since in the autumn Robert Nobel was contemplating converting the steamer into a floating sawmill. This scheme suggests that his business was not doing very well, and this was presumably one of the reasons which induced Robert Nobel to leave Petersburg in 1861 or 1862, and settle in Helsingfors. His motive for choosing this city may have been that he had married a Finnish lady in 1861, Pauline Lenngrém, the daughter of Karl Lenngrém, a fairly wealthy merchant and landowner in Helsingfors. He seems to have been engaged as early as January, 1860, as, according to his account book, he gave "Pauline" a silk dress that cost 90 roubles in that year, and a fur coat that cost 330 roubles. It appears from a later letter that his young wife did not like Russia, and that is presumably the reason why her husband emigrated to her country, which he however did not care for.

Nobel seems to have started a brick manufacturing business, but in 1863, when the account book was started again, he appears as the proprietor of the Aurora Lamp Oil business. He took on A. F. Sundgren as a partner, the business being run in the latter's name

since Nobel, as a foreigner, failed to obtain permission to carry on a business. The necessary capital was provided as a loan of 12,000 roubles by a Doctor Busch of Dorpat. He says humorously in a letter that his lamp business might be called "brilliant," but that he was doing very poorly financially, and he wrote to Alfred Nobel: "Regarding my new and brilliant position from your point of view, you must imagine that I am the only person bringing enlightenment to the worthy Finns, and that I bathe in pure petroleum out of sheer self-satisfaction: but that, I assure you, my dear brother, is an error. No such honour is mine, for before I had the slightest idea of what was happening, I found that I had two competitors in this honourable profession. Prices were forced down, and as I have had to pay extremely high rates both for lamps and petroleum in Petersburg, my profit is nil. It is true that I make a little producing new articles and in altering oil and spirit lamps, but that has to be written off against my stock of unsold lamps and petroleum, in respect of which I shall have to enter a loss next autumn, owing to the fall in prices."

In another letter, written in 1864, he continues: "With the best will in the world, it is impossible to keep afloat for long in a stormy sea with two empty hands; you work till you are exhausted, the rags that you wear get soaked, and you sink deeper and deeper although you fight ceaselessly against the storm. Who, in Heaven's name, would have imagined in earlier days that things could go so ill and reach such an impossible position, when our star shone so bright in the east? It is true that I was prepared for things to change, but I had never dreamt that times could be as bad as they seem to be getting."

But in spite of his business difficulties, these years were not without importance for Robert Nobel's future. Although on a very modest scale, he was dealing in petroleum, and thus became acquainted with the fuel which was afterwards, through his efforts,

to become of such importance to Russia. On one occasion he had bought twelve barrels of photogen in Brussels, but the stuff proved to be of such poor quality that it was unsaleable. The quantity was inconsiderable—especially as compared with the production of the Baku oilworks—but twelve barrels meant a lot to the poor lamp dealer, and Nobel feared ruin. After some experiments, however, he succeeded in refining the stuff in a Finnish factory, and he then disposed of it without incurring too great a loss. This was one of the experiences to which he owed the great achievements of his later life.

In the meantime Alfred had made his important discovery of nitro-glycerine, and Robert became acquainted with the manufacture and application of the new explosive when he visited Stockholm in the autumn of 1864. He had not been inclined to believe much in such discoveries, and had, shortly before, in May, given his brother Alfred advice which the latter fortunately failed to follow:

"MY GOOD ALFRED," he wrote,

"Give up inventing as soon as possible. It only brings disappointment. You have such wide knowledge and such exceptional qualities that you should turn your attention to more serious matters. If I had your knowledge and your capacities I would spread my wings, even in this wretched country of Finland. But as it is I am doing only moderately . . ."

When he reached Stockholm, however, he found that nitro-glycerine was a business with a future, and Alfred and his father presented him with the right to patent and exploit the invention in Finland on his own account, but in Alfred's name. The patent which was granted on the 9th December, 1864, for a period of five years, is in the same terms as Alfred Nobel's Swedish patent of the 15th July, 1864. In the spring of 1865 Robert built a small nitro-

glycerine factory on a piece of land which he rented, on the property of Fredriksberg, near Helsingfors. The manufacture and sale of nitro-glycerine was started in August, 1865, and Robert Nobel concentrated his energies on getting the new explosive known. On the 21st September, 1865, the following advertisement appeared in the Helsingfors *Dagblad*.

" At the request of the undersigned, the Master of Canals and Bridges has given permission for two big trial explosions with nitro-glycerine, and two with gunpowder, for purposes of comparison, to be carried out below the Russian Church at Skatudden, near the North Harbour. Anybody interested in the matter is invited to attend these trials, which will take place to-morrow, Wednesday, the 27th September, at five o'clock in the afternoon. The best and safest place for observing them is the corner at Kyrkogatan and Norra Kagaen.

" The nitro-glycerine explosion will be announced by a red flag, and the gunpowder explosion by a white flag.

" R. NOBEL, manufacturer of nitro-glycerine."

According to the report of the Helsingfors *Dagblad*, the effect was " astounding." Similar trial explosions were then held in country towns, at Abo and elsewhere, and for the period of a year, besides carrying on his lamp business, Robert was keenly engaged in making technical improvements in the manufacture of nitro-glycerine, and in promoting its sale.

Robert was not very happy in Finland ; business was dull, and in May, 1866, he therefore accepted the Nitro-glycerine Company of Stockholm's offer of the position of salesman and business manager, with a salary of 6,000 kronen, which was then regarded as magnificent. The position, however, had its unpleasant side, and at the end of 1870 he returned to Petersburg, and joined Ludwig's business.

We must now turn our attention to Robert's brother, Ludwig, who was nearly two years younger, Robert having been born on the 8th August, 1829, and Ludwig on the 27th July, 1831. In his father's Petersburg workshops he had developed into a first class mechanical engineer, and when Immanuel went to Sweden, in 1859, he accepted from the creditors of the firm, the commission to carry on and wind up the business of the *Atéliers mécaniques Nobel & fils*. He had married his cousin Mina Ahlsell in 1858, and his eldest son, Emanuel, had been born in Petersburg on the 10th June, 1859, that is, just at the time when his father was leaving for Sweden.

His employment as representative of the creditors did not last long. He had been able to save a small capital sum out of his earnings—5,000 roubles, according to a later statement of his—and on the 1st October, 1862, he started business on his own account. He took over a small workshop at Ichervod, near Viborg, which he first rented and then bought. Under his management it soon developed into an important undertaking which was not merely well up to the technical standards of the time, but in many respects in advance of them. They produced primarily all kinds of weapons and war materials, such as firearms, guns and gun carriages, submarine mines and other armaments; and also instruments for boring and drilling, steam hammers, hydraulic presses, etc.

Ludwig Nobel devoted special efforts in the 'sixties and 'seventies to the manufacture of firearms. Between 1867 and 1870 100,000 muskets were converted in his workshops from muzzle loaders into breech loaders (according to the system of Kerle and Krinka). His proposal for introducing the magazine loading system was not accepted, but it probably constituted one of the earliest important attempts at a solution of the problem. In 1871 he and a Russian friend of his youth, Captain P. A. Bilderling, as he then was, received the joint commission to organise the production of 200,000 Berdan rifles in the State factory of Ishev, near Perm. They

rented the factory for eight years; the machine tools were manufactured in Ludwig Nobel's workshops, and Ludwig Nobel, with his engineers and foremen, directed the manufacture from the start. The Government's orders gradually increased, with the result that over 450,000 rifles were delivered in eight years.

Meanwhile, as we have seen, Robert Nobel had been taken on in his brother's business in 1870, so that this year marked the collaboration of these two brothers, which was to develop on an entirely different line.

A better kind of wood was required for the butts of rifles than was to be found in the neighbourhood of Petersburg, and it was also desirable to become independent of foreign walnut wood. As there was walnut in the Caucasus, his brother asked Robert Nobel in 1873 to go there and organise the felling and delivery of this wood. The scheme proved impracticable, as the trees were too widely scattered, but during his stay in the Caucasus Robert Nobel's attention was drawn to the abundant supplies of naphtha at Baku, which were then being exploited in an extremely primitive manner. On his return to Petersburg, he told Ludwig of what he had seen, and succeeded in interesting him, and in persuading him to join him in the establishment of a small naphtha works. Robert returned to Baku in 1875, and devoted himself in that, and the following years, to the hard poineer work of founding and developing a new world industry.

Although the oil wells of Baku have been known since the beginning of history, they had never acquired any importance for world trade before the time of the Nobel brothers. American oil then dominated the market, a fact which was partly due to the geographical position of the Russian oil fields. Baku lies on the Caspian Sea, and before the railway from Baku to Batum was built, Baku was quite cut off from communication with the rest of the world, for the Volga freezes over in winter. There were, however,

other obstacles also to the development of the oil wells. When Russia acquired this district from Persia at the beginning of the nineteenth century, as the result of a successful war, she made the production of oil a State monopoly, and leased it to two Russian merchants named Mirzoeff and Kokoreff. As is usual when an industry is monopolised, instead of being left open to free competition, it was let down, and during the period up to 1872, when the monopoly was abolished, the Americans succeeded in acquiring control, not only of the world market, but also of the whole market of Russia. As a crowning act of mismanagement, the Russian Government had imposed an export duty on oil which remained in force until 1877. The Russian Government's receipts from the monopoly were quite insignificant, amounting to about 100,000 roubles a year, and in 1872, the last year of the monopoly, the total production of oil did not quite amount to 25,000 tons.

When the monopoly was abolished and the district was sold in lots, several new oil companies came into being, the most important of which belonged to Mirzoeff, one of the former agents for the monopoly. In 1875 the brothers Nobel entered the field, and through a series of technical improvements they soon overshadowed the other firms. The Balakhani oil fields are rather more than ten kilometres distant from Baku, and the oil was carried from the Balakhani wells to the refineries on the harbour, in great barrels, which were loaded on to a particular kind of high two-wheeled carts known as "arbas" in the Tartar language. The cost of this was naturally enormous, and is stated to have amounted to nearly a million kronen in a year. The Nobel brothers, on the other hand, built a pipe line, and later several, through which the oil was pumped to Baku. It was not at all easy to introduce a novelty of this kind in a newly conquered country which was in every way backward. The owners of the arbas, believing their livelihood to be at stake, were exceedingly hostile, and the Nobel brothers were

compelled to establish a series of sentry posts for the protection of their pipe line, armed watchmen keeping guard lest an attack should be made upon them.

Production rapidly increased. We have mentioned certain figures for the year 1872. Ten years later, 680,000 tons were pumped through the pipe lines to Baku. In 1872 the price was 7s. 9d. and in the year 1882 it had fallen to 2s. 6d. The production of refined oil, which did not amount to quite 100,000 tons in 1878, had increased to over 200,000 tons by 1883. These facts are taken from an English book by Charles Marvin, called *The Region of Eternal Fire*, published in 1884, the descriptions in which give perhaps the best picture of the achievements of the Nobel brothers.

"Yet these two Swedes, Robert and Ludwig Nobel" he writes, "have as completely revolutionised the Russian petroleum industry, and the Russian industrial and political position in the Caspian as Alfred Nobel has transformed mining operations and the art of war, and given incalculable power to democracy, by his discovery of dynamite."

Nobel Brothers' Petroleum Production Company now control a capital of £1,500,000 sterling, paying on an average a dividend of twenty per cent. At the oil fields of Balakhani they have over forty wells, of which fourteen are "fountains." One of the latter, as I have already said, yielded last year 112,000 tons of crude oil in a month. Two pipe-lines, each eight miles long, and able to convey 4,000,000 barrels yearly, connect the wells with the refinery in the Black Town of Baku. . . . The refinery covers more than a mile of ground. . . . Each of its large refuse reservoirs holds 4,000,000 gallons of liquid fuel at a time. On the Caspian the firm have twelve large cistern steamers, costing over £250,000 sterling; twelve steamers and forty barges on the Volga, and a dockyard at Astrakhan, costing collectively £180,000; besides which, they charter a large number of schooners and barges every season from

other owners. At Tsaritzin, and twenty-six other points in Russia, they . . . have placed on the railways 1,500 tank-cars at a cost of more than £275,000. Altogether their organisation gives employment to not less than 5,000 people, and at times this has been raised to double the number."

As is well known, bribery and corruption were not uncommon phenomena in Russia, and it is best not to enquire into the origin of several fortunes made in that country. Charles Marvin, however, goes on to state : " The Nobels have amassed their fortunes by an honesty and a broadness of principle, rare even in England to-day. Their generosity towards their employees is remarkable. Outside Baku a handsome suburb is rising on the coast of the bay. It is really a walled park, to contain when complete fifteen beautifully designed stone bungalow-villas, with lodgings for several hundred persons. These are surrounded by hundreds of trees brought from the Volga and irrigated by fresh water conveyed thence by the oil steamers on their return journey. This suburb is Villa Petrolia, where Nobel's chief employees will form a colony and live under conditions of comfort which many an English capitalist might copy with benefit to those beneath him. A public library is being built for them, billiard-tables have been sent to amuse them, and a sort of co-operating principle has been introduced enabling the employees to invest their money in and participate in the profits of the firm."

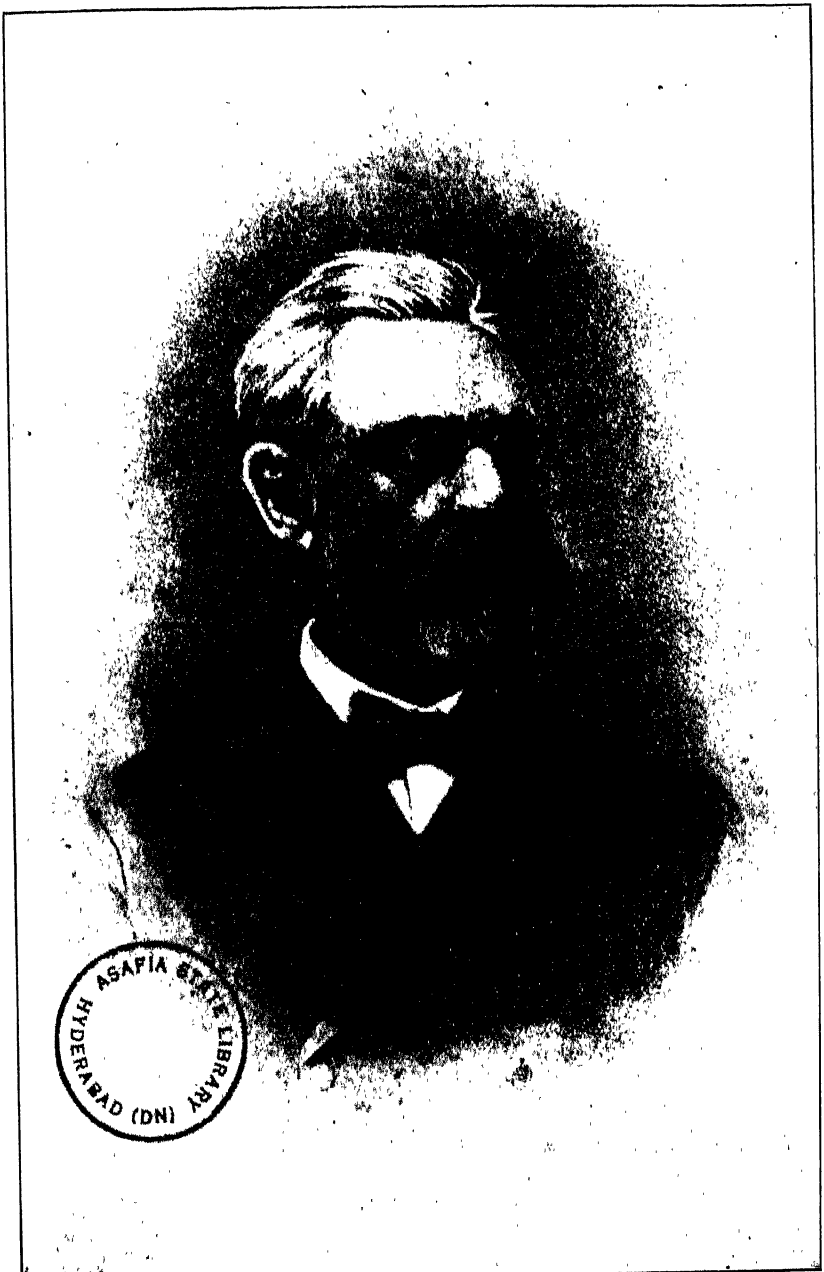
The brothers' Nobel naphtha company was not merely a great technical and industrial achievement, it constituted a great financial achievement too ; for when Robert and Ludwig Nobel began business, in 1875, they were far from being financial magnates. This was where their third brother Alfred, came to their assistance.

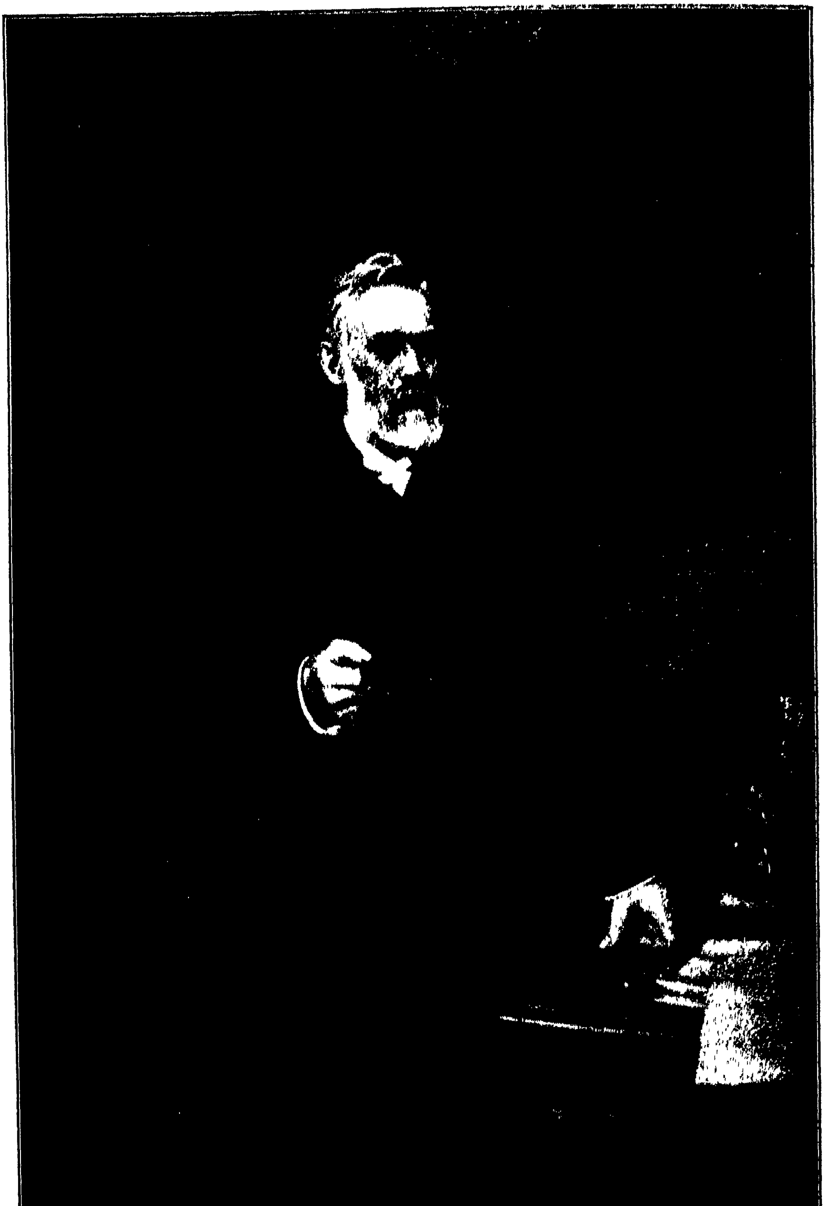
After his first visit, Robert Nobel returned to Baku in the autumn of 1875. Ludwig, who had first meant to travel with him, was detained in Petersburg by his other business, and postponed

his visit to Baku to the following spring, as he wrote to Alfred on the 31st October, 1875. He hoped that Alfred would accompany him. He wrote to him on New Year's Eve (Russian calendar) of that year: "Robert has returned to Baku from a journey to the east coast (of the Caspian Sea), and has found excellent naphtha on the island of Tcheleken at a depth of ten fathoms. He therefore has the raw material he needs. We shall see now what capacity he has for organising its production and sale on a large scale. His future success and fortune depend upon that. I, for my part, have done what I could in coming to his assistance with money and with technical advice. Robert states that he has made new discoveries for distilling and refining oil, the value of which I cannot judge, since I am not familiar with the matter. The most important thing is to understand how to carry on the business intelligently on a large scale. I constantly feel that we, i.e., you and I, ought to go there together to see whether we cannot help him in any way. We have succeeded in achieving independence, and we should therefore endeavour to assist Robert to achieve it also. So I want you to think over the journey to Baku."

During the following eight or ten years the brothers constantly returned to this suggestion that Alfred should go with them to Baku, in order to convince himself by personal experience of the possibilities, but their persuasions were of no avail.

Meanwhile Alfred followed the uninterrupted development of the Baku undertaking, as described in the letters of Ludwig, with whom he had at that time a joint interest in the Russian dynamite business. In 1876 Ludwig wrote, after his return from a lengthy journey to the Causasus, where at Tiflis he had met the Grand Duke Michael, and had succeeded in interesting him keenly in the naphtha works. "The position at Baku is that the factory is at last finished, and work has started. Its output capacity is considerable, and with the present installation, may be





LUDWIG NOBEL

reckoned at half a million pud per annum. By duplicating the machinery, which is not a very expensive matter, as the buildings are finished, the output may be doubled, or even quadrupled. We shall thus be able, at almost any time, subject to transport and storing arrangements, to produce two million pud annually. But this is the whole problem. As for quality, Robert has achieved really splendid results, for whereas the Baku yield is generally only 30 per cent, and a heavy and inferior product at that, he produces from the same naphtha 40 per cent of good light photogen, fully comparable to the best quality American. We can therefore enter the market at the start with a product that will give the firm a splendid reputation."*

In the spring of 1877 Ludwig spent some time with his brother in Paris, and from that time Alfred co-operated financially in the Baku works. In May 1878 the brothers agreed to form the undertaking into a company to be called The Nobel Brothers' Naphtha Company, of which the three brothers, Ludwig, Robert and Alfred, and Ludwig's old friend and partner in the Ishef business, Colonel Peter Bilderling, were original members. The capital sunk in the business, which had been so far chiefly provided by Ludwig, who had been the only person to finance it, amounted at the time to approximately 800,000 silver roubles, or about 3,200,000 francs (according to the rate of exchange agreed upon).

The Articles of Association, as approved by the Emperor on the 18th May, 1879, fixed the original share capital at 3,000,000 roubles.

The Articles contained a number of provisions that are fairly typical of Nobel's ideas as a manufacturer and business man, and of which the following may be worthy of mention. The capital of

* In the beginning the factory bought naphtha from existing oil wells at Balakhani. Borings on their own territory were begun, but it was five years before the first oil was obtained from them. The number of boring stations was gradually increased, so that the Company became more independent of other supplies of the raw material.

three million roubles was divided into six hundred shares—so-called Paj—of five thousand roubles nominal value, which conferred the right to vote in general meeting, only after they had been held by a new transferree for six months. The object of this provision was to prevent speculation of the shares on the Bourse.

The following profit-sharing scheme was incorporated for the benefit of the managers and other servants of the company. After 8 per cent on the share capital had been paid out of a year's profit, 40 per cent of the surplus was distributed in fixed proportions amongst the management and the employees, the balance being at the disposal of the shareholders. This profit-sharing system, from which the servants of the company gradually received very considerable dividends, was maintained until the Russian Revolution put an end to the company's activities.

Alfred Nobel's first cash payment to the company was limited to 300,000 francs, but in the following years he subscribed to a series of new issues of shares and debentures which were necessitated by the developments of the company. At the same time he helped to secure the financial foundations of the company, both by direct loans, and by lending the company Russian State Bonds, which they were able to use as security—so-called Salog—for the due payment of taxes on the scale of naphtha products. He also lent his own debentures of the company itself to serve as a mortage for credits granted by the Russian Imperial Bank.

On his death Alfred held shares in the company to the value of 2,000,000 roubles, and claims on the company to the value of about 2,000,000 kronen. At earlier periods his interests in the company had been considerably more extensive.

The progress of the Naphtha Company during the twelve years between 1876 and 1888, that is, until the death of Ludwig Nobel, had been unparallelled, according to European standards of the time, while in Russia itself the phenomenon was almost unique. It

made the most severe demands upon the management, in the solution of problems of a financial, administrative and technical nature. The technical problems fell broadly into two classes, each of which was important. The first set were concerned with the carrying out of boring operations in and around Baku, that is to say, practically in the desert, and the establishment of a distilling and refining industry for the manufacture of products—photogen, lubricating and fuel oils, etc.—which should be able to compete in cheapness and quality with the American article. The second set of problems were no less important: it was necessary to create a system for the transport and distribution of the products, first in the Russian market and then abroad.

In this connection Ludwig Nobel's ideas were particularly fruitful. At the beginning—before the construction of the Trans-Caucasian Railway opened up a new route from Batum to the Black Sea—transport was exclusively by water, over the Caspian Sea to Astrakhan and Zaritzan on the Volga and from there partly by rail and partly by river to the interior of Russia. The river was navigable only in summer for about seven months; whereas the consumption of photogen was naturally at its height during the dark period of the year. The earlier system was to transport and warehouse photogen exclusively in barrels. Ludwig introduced ship and rail transport in tank ships and cistern trucks, and warehousing in cistern dumps. The tank steamers must be regarded as the most important link in this system of transport, and they constitute indeed one of Ludwig Nobel's most important achievements in the field of general technical development. Previously there had been no possibility of fully developing Baku's immense oil resources for meeting the needs of the great Russian Empire, for the transport of such enormous quantities of oil—photogen as well as fuel oil (Masut) and lubricating oil—would have been technically and financially impracticable in barrels. It is true that

the tank ship was not entirely a novel idea ; flat bottomed tankers had already been used on American rivers, and a tank steamer had also been built experimentally for trans-Atlantic transport. But the experiment was a failure ; the steamer proved so unseaworthy that after the first voyage she had to be laid up in Antwerp Harbour.

The first really practical type of seaworthy tanker was built according to Ludwig Nobel's scheme by S. Almkvist, who was then head of the Motala workshops in Sweden. She proved to be the model, not merely for a whole fleet of tankers constructed for transport on the Caspian Sea, but for the whole of tanker tonnage which nowadays serves the constantly increasing transport requirements for motor, lighting and fuel oil throughout the world.

At the beginning the ships were constructed exclusively in Sweden. Up to 1898 fifty-three petroleum steam tankers, capable of carrying about 80,000 tons of oil and valued at 12,000,000 kronen had been built in Swedish dockyards for delivery to Russia. The voyage from the Baltic to the Caspian Sea was a problem in itself that was not without certain dangers. The ships went up the Neva from Petersburg, crossed the lake Ladoga, and went up the Svir to the Onega lake. From there they were brought through the so-called Marinski canal to the Bjelo-Osero lake, and thence to the Sheksna, a tributary of the Volga, only using the Volga itself from the neighbourhood of Jaroslav to the Caspian Sea. The voyage through comparatively shallow canals and the rapid and difficult Sheksna river was possible for steamers of this size only during the short period of high water in the spring. There was the possibility that if a ship started too late she might be held up for over a year on the Bjelo-Osoro lake, waiting for the high water of the following spring. The larger of the Nobel steamers being too long to pass through the Sheksna locks, had to be built in such a way that they could be divided into two halves ; and when they reached the

Volga they were reassembled, after which the ship continued her voyage to Baku in the ordinary way. As the water at the mouth of the Volga is too shallow for heavily laden ships, transhipment stations were built outside in the roadstead on anchored pontoons, with the assistance of which the consignments of petroleum were unloaded from the steamers on to flat-bottomed tankers for their further transport up the Volga. These stations in the middle of the roadstead were named after the depth of water, i.e., Twelve Feet, Ten Feet, etc.

Cistern dumps were built at a series of wharves on the Volga between Zaritzin and Nijninovgorod, whence lamp oil and its by-products were retransported in tank trucks over a whole network of smaller and larger dumps that were scattered throughout the whole of Russia. When the Trans-Caucasian Railway was completed Batum became a dumping and trans-shipment centre of the greatest importance.

"This extensive organisation," one of Nobel's most trusted colleagues wrote, "was an undertaking such as would naturally appeal to a man of Ludwig Nobel's stamp. To assemble the fruits of technical investigation, creative endeavour and accumulated capital, convert them into the most impressive store of wealth, and then extravagantly to distribute these spiritual and material gifts, and to watch their transformation and their conversion into a gigantic structure under whose protection human life would become happier and civilisation would be enriched, must have been a source of joy and satisfaction, as indeed it was. Thus the work was carried out with thoroughness, with enthusiasm and with love." The structure was so well and surely built that it was able to stand the subversive effects of a later period.

During the first five years the brothers Robert and Ludwig had divided the work amongst themselves in such a way that Ludwig remained in Petersburg in charge of the business management,

whilst Robert lived at Baku, in order technically to organise and direct the new undertaking on the spot. But Robert's health was such that he could not stand the climate for long. In 1879 he became seriously ill, and when he recovered, in 1880, he was compelled to retire. He went across to Sweden, where he bought the estate of Geta, on the Braviken fjiord, where he remained until his death, in 1896, only a few months before that of his brother Alfred.

When Robert retired Ludwig was compelled to carry on the two great independent businesses in Petersburg and Baku alone. His letters to Alfred, written in the early 'eighties, give an impressive picture of the restless energy that he shewed in the development and administration of the enormous naphtha undertakings as well as of his personal initiative and resourcefulness, and his keen sense for valuable technical improvements suggested by others. He introduced improvements in the process of distilling, by adopting the continuous method of distilling naphtha through applying the principle of the counter-stream, whereby the waste products of distillation that flow off, known as astatki, or masut, which it had hitherto been necessary to cool with water to prevent them from igniting, were used to warm the raw oil. He introduced new and improved methods of heating with astatki, with the result that a waste product which had hitherto been almost worthless became widely used. He was the first person to apply Wittenström's system for using naphtha by-products to smelt steel. New processes for purifying fuel and lubricating oil were also evolved, whereby their quality was brought up the standard of American oil. He also took a keen interest in the use of oil as fuel for internal combustion motors, and he had simplified processes devised for the production of lighting gas from by-products of naphtha, as well as for treating these by-products in order to produce benzol, naphthaline, etc.

Both by temperament and training Ludwig Nobel was pre-

eminently an engineer and manufacturer. He devoted himself heart and soul to the undertakings to which he dedicated his life. He had a profound and unshakable faith in the future and the possibilities of these undertakings, especially of the naphtha company. But he had not been through the same bitter experiences in business matters as his brother Alfred, and he may have been more of an optimist by nature. Although otherwise accustomed to take his own decisions and to assume responsibilities himself, both in important and in trivial matters, he was happy to appeal to Alfred for advice in financial questions, and often relied upon his assistance.

In March, 1883, Alfred, for the first time since his youth, went to see Ludwig and spent a week with him in Petersburg. It had been decided to make a further considerable issue of shares of the naphtha company, and in accordance with the wish of Alfred who wanted the shares to be distributed over a large number of holders, a new class of shares was issued of the nominal value of 250 roubles each. The brothers Nobel, however, still retained the majority of the shares. After his brother left, Ludwig wrote on the 17th March, 1883, a letter containing the following extract.

" Your short stay here has left all of us, both grown-ups and youngsters, so many pleasant memories that we are still constantly talking about you. Your remarks have given me no little food for thought. Your long and extensive experience in the administration of public companies is of enormous value to me. Up to the present as the whole undertaking practically belongs to us alone, we have been able to regard it as a private business ; but now that shares, few though they be, have been sold to friends, we must start observing formalities, the importance of which I do not underestimate. I shall therefore act in accordance with your advice and your suggestion, so far as this may be practicable, having regard to the arbitrary methods of the higher authorities here."

At the general meeting of that year, Alfred was elected to serve on the board of the company. In his letter informing him of this fact, dated the 15th April, Ludwig again expressed in the warmest terms his admiration of his brother's work. He wrote: "The assistance you are giving us now is really of great value and I hope that when I have officially informed the manager that you have joined the board people will give up saying, as they are doing now, that the company of the Nobel brothers consists only of Ludwig Nobel."

The years 1882 and 1883, however, brought considerable difficulties and disappointments. Several explosions and fires occurred at Baku; the factory proved to have been constructed on too small a scale, while the original technical arrangements involved certain dangers, so that considerable reconstruction was necessary. One of the company's largest cargo steamers on the Caspian Sea, the *Nordenskjoeld*, was destroyed by an explosion and consequent fire. There was a delay over the delivery of other ships ordered in Sweden with the result that the transport of the naphtha products during the period when the waters were navigable, could not be carried out on the scale calculated upon. Moreover the considerable success of the Nobel Company had brought new competitors into the field, who endeavoured to imitate the methods of that company, especially their system of transport. This again caused a severe fall in the price of the finished products. Photogen, for instance, fell in one year to a third of its previous value. As a result of all these circumstances, the company got into an exceedingly difficult financial position. Attempts to float an issue of debentures in London, or to obtain a loan from a bank there, failed. Thanks however to Ludwig Nobel's unflagging energy and to Alfred's financial assistance, the difficulties were overcome. The debentures were afterwards issued in Berlin, where a separate company was founded with a share capital of one and a half million marks,

the *Deutsch-Russische Naphtha-Import-Gesellschaft* for the import and sale of Russian petroleum in Germany.

Ludwig Nobel's colleague, Dr. Lagerwall, has given the following description of the difficulties experienced in connection with this loan: "When, in the early '80's, Ludwig Nobel, and I as his representative, endeavoured to issue a debenture loan through the banks of the west of Europe, in order to consolidate his great undertaking, the problem was no less than to divert the flow of capital into a new channel. At that time State loans and railway debentures guaranteed by the State were the only form of capital investment in Russia known to the rest of Europe. We came on the scene offering securities in respect of a concern, one half of which consisted of borings, while our product was petroleum, an article which the public associated with wild incendiaries, and which the brokers associated with the wildest speculation.

"Nevertheless, we succeeded in the end. But the credit was not due to ourselves. We had in Berlin a counsellor and supporter in one of Ludwig Nobel's intimate friends, who had previously been associated with him in the delivery of firearms to the Russian Government. His name was Louis Berger, and for several years he had been a well known member, both of the Prussian Landtag and of the German Reichstag. Although he was entirely independent of any party he had no small influence by reason of his extraordinary personal charm and his rare combination of historical knowledge and practical business sense. It was through him we learnt that after the long period of coolness which had existed between the Prussian and the Russian Government, following upon the Congress of Berlin of 1878, the Germans had begun to seek for possibilities of restoring the cordial relations of former times. Bismarck had accordingly given the big Berlin banks a hint that the Government would appreciate it if they could create an atmosphere favourable to a political rapprochement by an accommodating spirit in financial

matters. Thus our real broker in the transaction was none other than the great Chancellor. He did a good work that day, not only for us but for the German banks concerned. . . .''

The big debenture loan served to finance the Nobel brothers' naphtha company for a time, and relieved it of pressing financial worries. Shortly afterwards, however, new difficulties arose.

In 1883 the Baku-Batum Railway had been completed, thereby affording the new Russian naphtha industry a fresh channel to the world market. The railway, which was supported by a State guarantee, had been built by a couple of entrepreneurs, one of whom, a Russian engineer called Palashkovsky, was also the owner of a petroleum refinery at Baku. Through his influence with the railway this man was in a position more or less to monoplise the limited transport facilities for the conveyance of petroleum which the railway afforded. As Palashkovosky's own financial position was a weak one, his business was offered through a Russian banker to the Paris Rothschilds, and they made a detailed investigation into the state of the Russian naphtha industry. The result was to show that the Nobel business was by far the best equipped and the best organised, and negotiations were started for co-operation. These, however, proved abortive, and the Rothschilds bought Palashkovsky's business. They also interested themselves in other refineries at Baku, which would otherwise have been forced into liquidation, but which now obtained a new lease of life.

The consequent intensification of competition resulted in a still further fall in the price of naphtha products ; and at the same time the general political unrest in Europe caused a serious fall in the value of Russian currency, as well as a financial crisis and a general restriction of credit. In 1885 the company paid a dividend of only two per cent. This disheartened the shareholders, and they tried to sell their holdings, with the result that the shares were quoted at a

heavy discount. The board of the company were criticised in various quarters. Alfred had retired from the board some time before, and he too criticised rather harshly his brother's actions, which he attributed to excessive optimism and a restless desire for expansion, which did not take sufficient account of financial risks. He did not, however, withdraw from the company the financial support which it needed, and Ludwig, who always retained his firm confidence in the business and its future, succeeded, by coming to the rescue with all his personal financial resources, in weathering this storm too. The struggle had, however, told severely on his physique, which had already been weakened by hard work and by a chronic affection of the throat. During the year 1887 he withdrew more and more from business, leaving the management of the naphtha company to his eldest son, Emanuel, while the younger son, Karl, devoted his energies to the Nobel workshops in Petersburg. Ludwig endeavoured to recover his energies on the Riviera, but he was already a doomed man, and he died, on the 12th April, 1888, at Cannes. We should have but a one-sided view of Ludwig Nobel's personality if we confined ourselves to a study of his qualities as an industrial leader. He was not merely an original and inventive man of business, he was also profoundly influenced by considerations affecting the communal welfare, and he was a fearless propagandist of new ideas.

It might be an exaggeration to assert that in the realisation of his impressive schemes for the organisation of the Russian naphtha industry he was influenced exclusively by idealistic motives; but it would be even more mistaken to attribute his extraordinary expenditure of work and energy entirely to the desire for profit. Such a view is irreconcilable with his guiding principles as a business man: to do nothing in secret; to acquire no monopoly; and to seek no special privilege. He immediately made available for general use many reforms and improvements which he

introduced, without ever claiming the exclusive exploitation of his new ideas, although that might have brought him great advantage.

Ludwig Nobel seems rather to have been an enthusiast for work. He wished to have nothing to do with unearned money, for such was contrary to his nature. His motto was, "He who does not work, need not eat." He never touched speculation on the Bourse. He was wont to reply to the many suggestions he received that he should sell his business profitably abroad, "You want me to turn my money into Bourse papers, and to buy scissors for cutting off coupons. But I do not need only money; I need work." What he liked in work was not the quiet routine, but the struggle, and the constant search for new methods. In a conversation with his shareholders he expressed his views as to the nature of an industrial undertaking as follows: "Do not imagine that an industrial undertaking is comparable to a house for which you want reliable tenants who will pay their rent. No, an industrial undertaking properly managed and well organised involves a constant struggle, and its success is dependent upon foresight, perseverance, industry and economy."

Any description of Ludwig Nobel would be incomplete without reference to his artistic qualities. In spite of his intense activity, Ludwig Nobel found time to devote himself to the reading of philosophy, which he so much enjoyed, and to good literature. He read in five languages, Swedish, Russian, French, German and English. Voltaire was his favourite author. Not only ideas, but plastic beauty also, appealed to him. He could appreciate art with real understanding; on the other hand he was entirely unmusical.

Ludwig Nobel was an exceedingly attractive personality. He was often abrupt and rough in conversation, but these superficial blemishes disappeared on closer acquaintance, and the high

qualities of a sensitive and receptive spirit were revealed. He was keenly interested in the life of the workers. He did not seek popularity nor did he flatter the workmen, but he was always actuated by motives of kindness, and he never allowed the claims of justice to be stifled by a selfish desire. His humanity and his consciousness of the social duties of capital to labour were a bright thread running through all his views on the labour question, and are expressed in the conditions of work he imposed and in his concern for the welfare of his workmen. He was an enthusiastic supporter of the movement for the complete suppression of the employment of children under twelve years of age. He did not deny that the complaints about the numerous holy days and the frequent malingering of Russian workmen were justified, but he did not regard this evil as insuperable. He persuaded his workmen voluntarily to reduce the number of holidays in a year to sixty-five, and he, on his part, reduced the working day from twelve and fourteen hours to ten and a half.

It was one of his principles always to associate his workmen in the fortunes of the undertaking, making their wages more or less dependent upon the profits realised by the factory. With all due recognition for the part played by capital, Ludwig Nobel declared that the success of a business could not be credited entirely to the owners; a portion of the dividends must be allotted to the employees, since it was upon their energy, carefulness and honesty that the success of the business depended. Thus and thus alone would a business become a community of persons united in striving towards a single goal. Ludwig Nobel already gave concrete expression to these opinions in the Ishev works.

In order to make it possible for his employees to make provision for a rainy day, and accumulate savings, Ludwig Nobel founded a savings bank, which was assisted with substantial contributions from the company. Ludwig Nobel did not merely

endeavour to make his workmen feel secure financially; he also tried, as far as possible to improve the conditions of life of his "peaceful children of industry" to the end that they might feel secure, and able to devote their faculties entirely to the responsibilities that they had undertaken. It rarely happened that an employee left of his own accord, since they all valued a position with Nobel.

Ludwig Nobel built a whole colony of houses for the workmen and engineers employed in the boring operations and the factories. The married workmen got quarters such as they could not possibly have got in the town. The unmarried workmen lived in communal dwellings. For those workmen who wished to live at Baku a steamer was provided which took them to work and home at fixed hours. For the clerical staff of the head office at Baku, Ludwig Nobel built a special settlement, the Villa Petrolea, with delightful, not to say magnificent houses for the departmental managers, technical experts, engineers, and other important officials. For the unmarried there was a communal dining-room and billiard-room, as well as a skittle alley and library, and a common room. Technical evenings were arranged there, meetings of what Ludwig used to call his Technical Club. The Villa Petrolea was situated on the sea, near the factory, and was built on sandy ground. To improve the place, Ludwig had a small park planted round the houses, and only a person familiar with the cheerless district of Baku can appreciate the efforts that were made to create an oasis there. Part of the soil was brought from Lenkoran (a town on the Caspian Sea), many miles distant, while the empty tankers brought fresh water on their return voyage from the Volga. The creation of this colony cost over 250,000 roubles.

Convinced that a compulsory but free school education for all children of a certain age constituted the only proper solution of the

question of workers' education, Ludwig Nobel constantly devoted himself to the establishment of schools. In the case of the Ishev works he created an educational fund in conjunction with the employees who, with the exception of the casual labourers and unskilled workmen, contributed one per cent of their wages, and he opened a technical college giving a three years' course. Four thousand roubles a year was spent on the upkeep of the college buildings alone, although there was no rent and the heating cost nothing. Ludwig founded two schools with fifty pupils each in the "Black City" and in Balakhani.

Ludwig Nobel's tireless efforts for their welfare was amply rewarded by the boundless devotion and profound affection that he won from all his colleagues, officials and workmen. Small and great were inspired with the warmest feeling for the head of the business; all were devoted to his interests. This perhaps constitutes the finest testimony to the pre-eminent spiritual qualities of this sympathetic and considerate employer.

In spite of considerable similarities in their general nature, gifts, talents, and characters, the three Nobel brothers, Robert, Ludwig and Alfred showed marked differences of temperament. They all had a fertile inventive gift coupled with a lively imagination. They were all three, although to a different degree, gifted with originality, vitality and industry. They had also all inherited to a certain degree something of their father's explosive temperament. Robert, however, concerned himself more with questions of detail; and he was more pessimistically inclined than his brothers, a tendency which was emphasised by his illness. Ludwig, as has already been stated was, above all, a born organiser and manufacturer. "A captain of industry" of extraordinary energy and power, and rare foresight. Alfred, who was the most gifted intellectually, had a remarkable business sense and high financial capacity, in addition to his inventive genius, and all his faculties

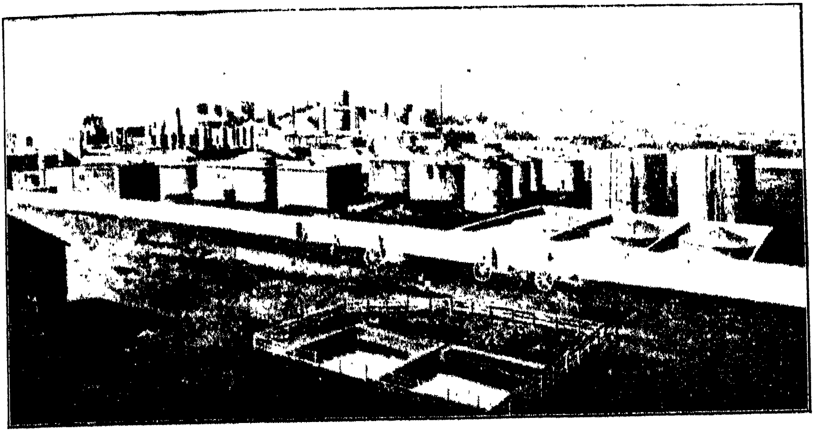
had been developed by the varieties of his early experiences; he had, however, no inclination to take a personal share in the administration and the direct management of the businesses that he founded. One gets the impression that for this reason he did not always fully understand and appreciate Ludwig's work in the naphtha company. In a letter to Robert dated the 7th July, 1883, he wrote: "Ludwig is not inclined to give up any of his authority and he will adhere to this system, which is telling on his health and undermining his strength. None of us is really healthy enough to manage such a gigantic mechanism as Baku. We must confine ourselves to the work of thinking, and leave all the mechanics to others."

The course of events fully proved Ludwig Nobel's foresightedness. It is true that for several years after his death his great business still had to fight with difficulties, but it came victorious out of the struggle, and continued its development under the management of his eldest son Emanuel, until it was taken out of the hands of the proprietors, in 1920, as a result of the revolution. It is not yet possible to judge how its future will develop; but it will be a long time before the achievements of three generations of Nobels for Russia's industrial and commercial development, and especially for the creation of the naphtha industry, are forgotten.

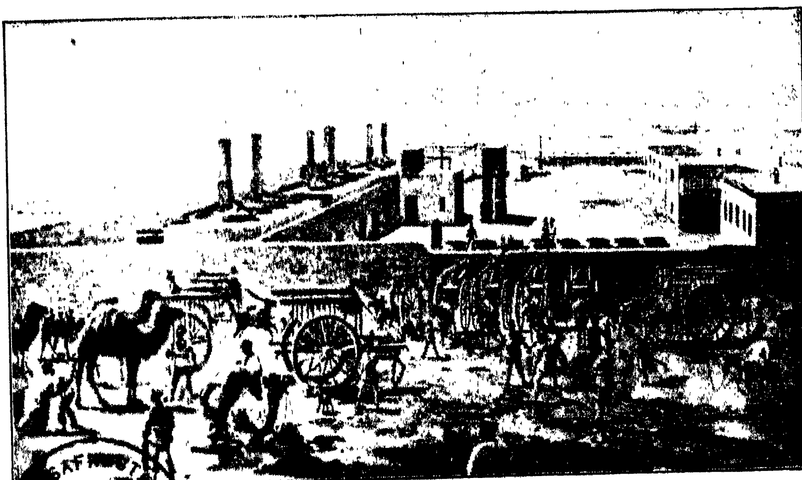
The following facts, amongst others, are recorded in a report of the Brothers Nobel and Company, dealing with its activities during the first twenty-five years of its existence:

During this period (1879-1904) the company made 433 borings to a total depth of 70,502 sashen (141 kilometres), and these borings had yielded over nine hundred million pud of naphtha.

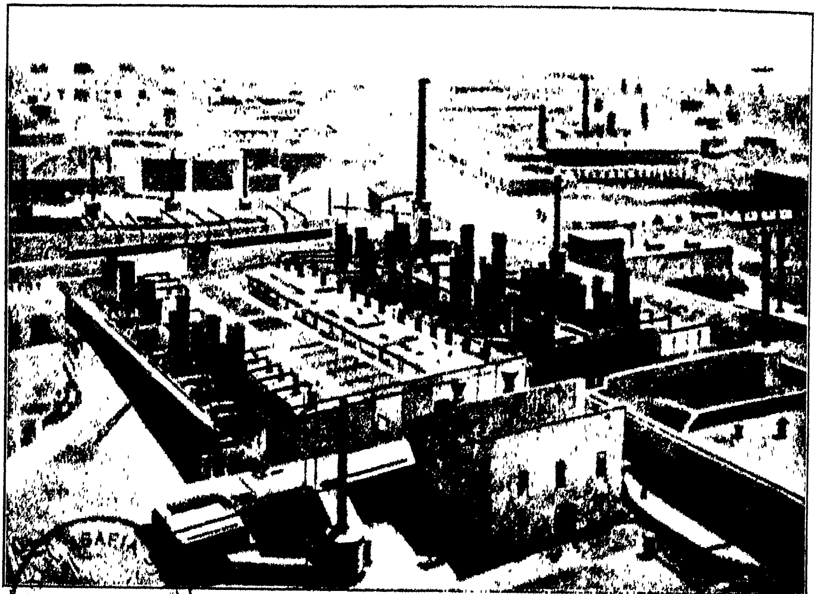
During the same period the company had refined 1,195,000,000 pud of their own and purchased naphtha; and in the company's



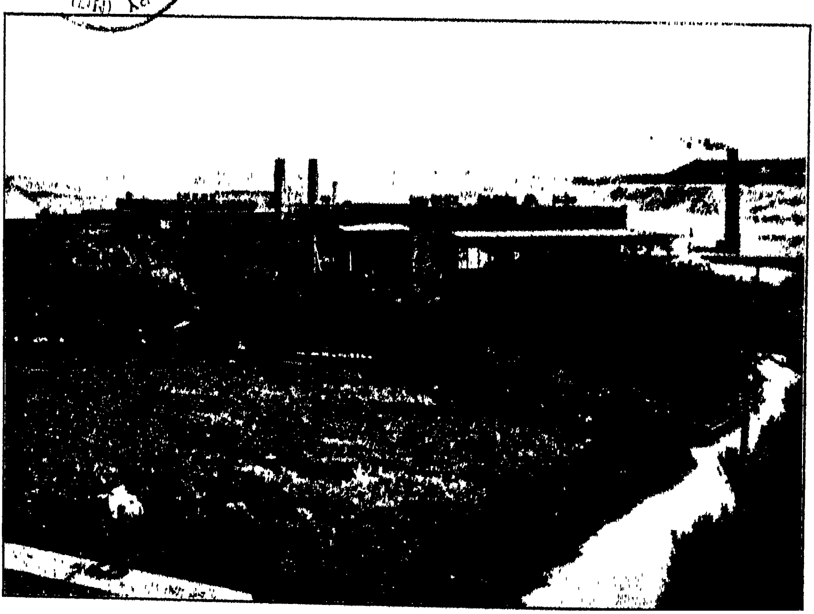
NAPTHA RESERVOIRS



METHOD OF TRANSPORTING NAPTHA



A PETROLEUM REFINERY



own factories, the following quantities of naphtha products were produced :

Petroleum	379,500,000 pud
Benzine	2,400,000 pud
Crude petroleum	46,300,000 pud
Lubricating oil	49,800,000 pud
Naphtha by-products	712,800,000 pud
Total	1190,800,000 pud

CHAPTER III

ALFRED NOBEL'S YOUTH

THE Nobel family do not seem to have been interested in their ancestry, and Immanuel Nobel was apparently under the impression that his grandfather was an English parson. Ludwig Nobel, however, began to make investigations and he accordingly asked his brother Alfred for a biographical account, and for any information that he could give throwing a light on the family history. Ludwig received the following reply to his letter: "Owing to pressure of business I am just now compelled to put off pressing duties and conclusion of contracts for weeks, sometimes for months. In these circumstances it is impossible for me to write a biography unless it is simply a record of facts, and such, in my opinion, are the most eloquent: *e.g.*, Alfred Nobel—his miserable existence should have been terminated at birth by a humane doctor as he drew his first howling breath. Principal virtues: keeping his nails clean and never being a burden to anyone. Principal faults: that he has no family, is bad tempered and has a poor digestion. One and only wish: not to be buried alive. Greatest sin: that he does not worship Mammon. Important events in his life: none.

"Is that not enough and more than enough? And what is there in our time that could properly deserve the title, important event? The ten thousand million suns that move in our little cosmic vortex called the milky way are themselves insignificant, and would be ashamed of their insignificance if they were conscious of the extent of the whole.

"Who has time to read biographical accounts? And who can be so simple or so good-natured as to be interested in them? I ask this in all seriousness."

It would appear that Ludwig Nobel continued to press him, and Alfred again refused, writing: "Why do you want to torment me with biographical essays. No one reads essays except about actors and murderers, preferably the latter, whether they have carried out their impressive deeds at home or on the field of battle. The family know practically everything there is to be known about our father, and it is a matter of small interest whether his biography is made available to the public or not."

This seems to have been his sincere opinion. At the Upsala Jubilee of 1893, however, having had the honorary degree of Doctor of Philosophy conferred upon him, he was under an obligation to send in his autobiography. He made it as short as possible.

"The undersigned was born on the 21st October, 1833; he acquired his knowledge in private studies, and did not attend any secondary school. He devoted himself particularly to applied chemistry, and discovered explosives known under the names of dynamite, and smokeless powder called Ballistite and C.89. Since 1884 he has been a member of the Royal Swedish Academy of Science, and is also a member of the Royal Society (London), and the *Société des Ingénieurs Civils* in Paris. Since 1880 he has been a knight of the Order of the Polar Star. He is an officer of the Legion of Honour. Sole publication: a paper in the English language, which was awarded a silver medal."

It is therefore scarcely open to question that Alfred Nobel was very little interested in biographies. He was interested least of all in his own. On the other hand, his attitude as to the opinion of others cannot be taken quite seriously. It is true that all human greatness is fundamentally insignificant, and that our own

earth is but a speck of dust in the immeasurable universe. But we must remember Pascal's aphorism: "Man is but a brittle reed, but he is a thinking reed. The universe does not need all its strength to break him; a gust of wind or a shower may suffice. But even though the universe destroy the reed, the reed is more than the universe that kills. For it knows that it dies, whereas the universe is unaware of its victory."

A full human life is something great, and a man cannot be measured according to the same standard as the milky way.

A life such as that of Alfred Nobel is worth the knowing; for he was undeniably a great man by reason not only of his gifts but also of his character and of his heart. But owing to the reserve which he maintained, such a biography can only be fragmentary, and extensive periods of his life's history must remain uncharted areas on the map of his life.

He was born at Stockholm on the 21st October, 1833, in a poor home. His parents were then living at No. 9, Norrlandsgatan, probably in the back part of the house. His father had recently filed his petition in bankruptcy, and the proceedings were not concluded until a year after Alfred's birth. When Alfred was four years old his father went to Finland to try his luck there, but as the outlook for the future was very uncertain, the family had to remain in Stockholm. It was here that Alfred grew up with his two elder brothers. In the spring of 1837 Robert entered the first class of Jacobs' preparatory school, to which Ludwig went in the autumn of 1839, Alfred being sent in the autumn of 1841, when he was just eight years old. He only spent one further term at the school, namely, the spring term of 1842, for in the autumn of that year the family left for Petersburg. Alfred's reports were magnificent. He was marked A for general intelligence, together with only three other pupils out of eighty-two in the class, and was also marked A for industry and conduct. He

received a similar report the following year, except that his conduct was marked B; a very creditable report in any case—he may have spoken in class, or been late. The reports seem to have been thought out quite meticulously, as a boy in the same class was awarded A for general intelligence, C for industry, and D for conduct, while Ludwig was marked B, BC and AB.

The two terms at Jacobs' were Alfred's sole experience of school, there being probably no Swedish school at Petersburg, where the three boys, who had reached approximately the same standard, were taught by a private tutor. It is not possible to ascertain who their tutor was, but it is probable that they had a Swedish tutor until the boys knew enough Russian; then, according to Dr. Emanuel Nobel's statement, a Russian was engaged, who must have been an exceptionally fine master, for his three pupils all became highly educated men, not merely engineers with a scientific training, but men with a knowledge and understanding of the humanities. In a letter written in September, 1848, when Alfred was nearly fifteen years old, their father endeavoured to give a description of his sons: "It would seem," he wrote, "that Providence has endeavoured to make up to the one any gifts which he has withheld from the others. In my opinion Ludwig has the most genius, Alfred the most industry, and Robert the most courage in speculation, combined with a pertinacity which amazed me last winter." This description was perhaps not entirely in accordance with the facts, for Alfred certainly had not merely the greatest capacity for work, he was also the greatest genius of the three. But fundamentally they all three had the qualities enumerated by their father, and they all three became important men. Although Robert was already nineteen years old at the time, the three brothers carried on with their joint studies under the tutor, from which we may infer that

Alfred, the youngest, was on an intellectual footing with his brothers. Ludwig had gone to Sweden on a visit, and his father wanted him to come back home.

" I cannot leave him in Sweden," he wrote, " for apart from the fact that it would involve me in great expense, it would also seriously disturb the work of my other children, whose thoughts are at present entirely centred on his return, when they can resume their studies together." Ludwig was back in January, 1849, and wrote to his uncle in Stockholm : " Alfred has grown so much that I hardly recognised him. He is almost as tall as I am, and his voice is so deep and gruff that I should hardly have recognised it." At the end of the year, however, Robert's education was regarded as complete, for in January, 1850, Immanuel Nobel wrote to his brother-in-law : " You will be astonished to hear that I have become a merchant in the first guild. My numerous interests have compelled me to take this step. Robert is looking after the outside business with industry and care, and by agreement with my partners, is paid a hundred silver roubles a month, a good salary for a young fellow of twenty ; but I am thankful to be able to say that he earns it." The correspondence does not show how long Alfred continued his studies under the tutor, but it seems probable that the three brothers terminated their studies at the same time. Alfred appears then to have been sent on his travels with a view to completing his education as an engineer. In a letter written to his uncle from Petersburg in July, 1852, he speaks of the time " when I was in America."

We get the impression that during these years he covered a good deal of ground. In one of the many begging letters that he received when he became rich, his correspondent writes : " In 1852 I had the honour of meeting you at Streit's Hotel in Hamburg, and you were kind enough to favour me with your attention . . . a week later we met in the town of Ystad in Sweden, when you

were on your way to Italy, on a steamer from Copenhagen." Assuming that the dates are correct, Alfred's stay in America cannot have been a very long one, and to judge by a youthful poem to which we shall refer again he seems to have spent most of his time in Paris. On his return home he, like his two elder brothers, was employed in his father's factory in Petersburg, and in January, 1856, the latter wrote to Ahlsell: "Another thing I have to be thankful for is that Ludwig's health is restored, and that he is consequently able to relieve me considerably in our numerous and arduous businesses. I wish that my dear industrious Alfred were also restored to health, as Ludwig is. That would be a great joy to us all, because both we parents and his brothers value him very highly, for his knowledge and his tireless industry, which is irreplaceable."

Such are the few certain data that we have about him in the 'fifties, this being the least known period of his life. According to ordinary accounts "he was generally travelling." According to the *Nordische Familienbuch*, "he studied his profession in several foreign laboratories, working with Professor Pelouze in Paris amongst others, where he had special opportunities of investigating nitro-glycerine and other explosives." The latter statement is, as we shall see, certainly wrong, for it was not until later that he began to interest himself in nitro-glycerine. The most complete information that we have is contained in an article in the *Nineteenth Century* of 1898: "Immanuel Nobel's pet idea at the time seems, however, to have been that steam could be superseded by heated air. He thought that it would be well to have one of his sons thoroughly trained to carry out this idea, and as Ludwig had become almost indispensable at the engineering works, and Robert was still abroad, he decided in 1850 to send Alfred, who was then sixteen years of age, to the United States to study under the well-known Swedish engineer, John

Ericsson.* Alfred Nobel was in America from his seventeenth to his twenty-first year, and then returned to St. Petersburg."

This statement is certainly correct in parts; but he did not stay in America for four years. Even if Alfred went there as early as 1850 and, as is a certain likelihood that the three brothers ended their studies simultaneously, he was certainly back by July, 1852, so that he was in America for two years at the outside, and not for four. It is also certain that he met John Ericsson, but his letter to Ahlsell suggests nothing more than a casual acquaintance. "When I was in America," he writes, "I arranged with a certain Captain Ericsson that he would send me certain drawings and designs that I required, which he could not finish during the time that I was in America. He is sending them to Herr Arfvedson in Stockholm." Nobel would certainly not have used the phrase "a certain Captain Ericsson" in a family letter if he had been sent out specially to work with him. In any case, as has been said, he was certainly back by July, 1852, when he entered the service of the company. As, however, he was rather an invalid, and seems to have worked particularly hard, he had to go to Franzensbad in the summer of 1854. He travelled via Stockholm, and spent some time with the Ahlsell family, some of it in Stockholm, and some at Dalarö. Some of his letters, written at that time to his uncle, have been preserved, and bearing in mind that they were written by a young man who was barely twenty-one years old, they show exceptional maturity. "On the 4th September," his first letter begins, "I at last got to Eger, where I started my baths and drink cure. (Drink cure is the right phrase because you put away an extraordinary amount of water here.) It is rather late in the year, but one proceeds with

* Well known as an inventor, and as the constructor of the first armoured ship, the Monitor, the use of which proved decisive in the naval battle of Hampton Roads, at which the Northern States established their superiority at sea over the Southern States of America. He also built the first propeller steamer.

the cure just as well." In a report dealing with various business transactions that he carried through for the firm, he continues: "But enough of business. It is a pleasure to be able to pass to memories of Stockholm and Dalarö. What jolly times I had then, compared to now! One realises what one loses by changing relations and friends for mere casual acquaintances with whom one can spend some pleasant hours, but from whom one parts with as little regret as from an old, worn-out coat." His next letter is written from Berlin during his journey home: "I am now at last beginning to hope that I shall soon see the end of this nomadic existence and be able to turn to one of greater activity. It is really time that it ended, because it is beginning to become boring not merely on account of the monotony, to which one would sooner or later become accustomed, but also because I feel that I am a burden to my parents and brothers instead of being able to help them, and although I have not succeeded in recovering my health as I had hoped (I believe my stay at Stockholm and at Dalarö did my health more good than my whole stay at Franzensbad), still I shall go home as soon as I have succeeded in finishing such business as I still have to do here in Berlin. I long for home more than I can say, and would like to be home on the twenty-first of this month, which will be my twenty-first birthday." When he got home he wrote to his uncle again asking him "to give to grandmother, out of the money standing on account, the whole of the allowance promised up to June, 1855; and we, Mamma and all of us, beg you, my dear uncle, not to allow her to be too careful with it, for, with God's help, it will last anyway, and we should all be so glad to be able to give her a little pleasure." The last letter of this period to his uncle is dated March, 1855: "It is now two months since I received your kind letter, but a tedious journey into the interior of Russia prevented me from answering it; such a journey is a perfectly legitimate excuse, as

it is as impossible to get pen and ink as it is to get ideas. Everything freezes in this desolation. . . ."

This is the last letter of his for a considerable period. His father's remark quoted above shows that he was still working for the company in 1856, and he was also working for it in September, 1857, when he received his first patent in Petersburg for a gasometer. It was shortly afterwards that the crisis in the Nobel factory occurred, and Alfred was sent at the end of 1858 to London and Paris to endeavour to raise the necessary funds to carry on; in this, however, he was unsuccessful, and in 1859 his father went to Sweden. It is generally stated that Alfred followed him there, but this was not the case, for when his father left he was dangerously ill and if he was in Stockholm before 1863, it can only have been on a casual visit. According to the ratepayers' list, his brother Emil only was staying with his parents; when Alfred joined them in 1863, he was entered as being a member of a church in Petersburg. He cannot therefore have gone to Sweden with his father. And it also appears from Robert Nobel's account book, to which we have referred above, that Robert and Alfred were living together in Petersburg in 1860. Everything points to the fact that they were also working together at this time; it is probable that Alfred later had a position in Ludwig's armament factory.

Alfred came to Stockholm in 1863 as the result of letters from his father, one of which, dated the 3rd July, 1863, has been preserved. In that letter Immanuel wrote: "I am now at last able to tell you that I have achieved a really fruitful result with gunpowder, which I can now produce at an insignificant cost, and in the same quality as the best French shot-gun powder. The manufacture of this powder might develop into an enormous business, especially in Russia, as the annual consumption of gunpowder in that country amounts to 200,000 lbs., in addition to which they require to have a supply of 400,000 lbs. in reserve. We are bound

to make 20 öre on each lb., so that you see the business is not to be sniffed at, and we shall be sure to make good all our losses in Russia. So you must come home as quickly as possible, to help your old father, and to look after this business here and abroad."

Alfred Nobel did come to Stockholm more than once, but the old man had again been too sanguine, for his discovery later proved to be a pure chimera.* Meanwhile Alfred was beginning to interest himself in the new nitro-glycerine, or rather he had already directed his attention to this problem, in which he had been interested by a Professor Sinin in Petersburg. In May or June, 1862, in the presence of his brothers, Robert and Ludwig, he succeeded for the first time in causing nitro-glycerine to explode, and, indeed, to do so under water. On the 14th October, 1863, Alfred Nobel received his first patent for this product, and on the 15th July, 1864, his second patent. It was just during these experiments that a slight estrangement occurred between the father and son, but the misunderstanding was of very short duration. While Alfred was a scientifically trained chemist, old Nobel was a mere amateur; but he considered himself to be the real discoverer of the invention, and Alfred accordingly set out the position in a letter, which is quite characteristic of the relations between the two. The letter is distinctly brusque, but manly and straightforward, and it does not transgress the obligations of filial regard. We quote a few extracts below, as they are not offensive to either party. The letter starts:

"My Dear Father,—

"You yourself thought that we ought to clear up matters between us. I entirely share your view, especially as I do not wish to expose myself again to such reprimands as I have been

* One suggestion was concerned with the use of chlorate powder in fire-arms, and the other with the adding of nitro-glycerine to ordinary black powder.

favoured with recently, which become neither their author nor the object of them. I shall therefore pass under review our recent dealings with one another.

"When you first wrote to me in Petersburg, you gave me to understand that the new explosive powder (chlorate powder) was a fully worked-out invention, and that it was twenty times as powerful as ordinary powder. I was asked to go to General Totleben with this story, which I did, except that I had the prudence to say that the powder was only eight times as strong. At your request I then came to Sweden, and found that your statements had been based upon an inconclusive experiment in a lead pipe. The result was a complete fiasco. . . . This journey itself proves that you had put aside all thoughts of glycerine powder, and regarded it as impracticable, or not sufficiently thought out. Meanwhile, in accordance with Ludwig's sensible advice, I had decided not to discredit myself or us by recommending chloric acid powder, and I began to work on pyro-glycerine in Petersburg on my own account. I did in fact succeed in producing astonishing results with experiments on a small scale under water. This was effected by means of glass tubes, surrounded by powder; Robert and Ludwig were present at the experiment, and when I arrived it was repeated in your presence and Emil's. . . . As the experiment had been so successful on a small scale, it had been my intention to invite Totleben to be present at a more elaborate experiment, whereupon the powder would probably have been accepted. But just at the critical moment a further letter arrived from you, with a new story about a powder that was alleged to be twice as powerful as ordinary powder, and to foul the gun only one-tenth as much. This letter contained a request to me to return in order to look after the business.

"It turned out that this idea had been thought out as little as the other. Even before I left, Emil had made the discovery

that granular powder, which has absorbed pyro-glycerine up to saturation point, produces a more powerful explosion in a closed vessel than ordinary powder. As to what happened afterwards, all I know is that the results achieved after my arrival were most inconclusive and that we wasted the whole summer with experiments which a competent person could have carried out in one day. Thereupon I returned to the method of blasting with tubes surrounded by powder, which method I had already tried in Petersburg, and so far from regarding this idea as yours, you made fun of me on account of it. . . . I then decided to make a bid for independence, and to devise a means of achieving my object without friction and unpleasantness. As the result of theoretic research into what took place during the explosion, I arrived at a principle which I had already suspected, and which is entirely different from that which underlies your use of glycerine powder, the principle being that if a small amount of pyro-glycerine be rapidly caused to explode, the shock and the heat generated will communicate the explosion to the whole mass."

This letter did in fact produce the desired result; old Nobel recognised that he had been unjust, and insisted that his son should receive the patent, as inventor. We shall later record a detailed report dealing with the history of the discovery, and the similar experiments made by Immanuel Nobel at the same time. As a result of the straightforward manner in which Alfred Nobel had cleared up the situation, the old friendly relations between the father and son were restored. Alfred's mother, who had been on his side throughout, contributed to this result, and in a later letter to him she wrote that he had been right to refute all those accusations which he had been the last to deserve.

"What a return for all your trouble and worry," she wrote. "The question would not be settled, even now, if you had not dealt with it firmly. Of course my little Alfred will realise that

the old fellow's bad health is the principal reason for the irritable mood he sometimes displays."

On the son's side, however, the incident seems to have rankled slightly. In February, 1868, the father and son were jointly awarded the Letterstedt Prize of the Swedish Academy of Sciences "for outstanding original work in the realm of art, literature or science, or for important discoveries of practical value to mankind." The Academy had decided to award the prize "jointly to Herr I. Nobel, and his son, Herr Alfred Nobel; to the former for his services in connection with the use of nitro-glycerine as an explosive in general, and to the latter more particularly for the discovery of dynamite." The prize-winners were allowed to choose whether the prize should be in money or in the form of a gold medal. They chose a medal, which remained in the possession of the elder Nobel. As we shall see later, Alfred Nobel waived his claim to any of his mother's property, keeping only a few small things, including the Letterstedt Medal. He wrote to the executor: "The Letterstedt Medal may as well come to me. I understand perfectly what my mother meant when she wrote, 'It belongs to Alfred Nobel.' My mother knew a lot of things that the public is not aware of."

The incident had left a scar, but the father and son continued to work together after this controversy without further friction, and began to put the new explosive on the market, although only in very small quantities. Then, on the 3rd September, 1864, the terrible explosion occurred which entirely undermined the old man's strength. At this critical period Alfred devoted all his energies to saving the business, which seemed to be inevitably doomed to disaster. He was assisted in this by his aunt, a certain Frau Elde, who introduced him to a certain Swedish millionaire, J. W. Smitt, who appreciated the importance of the discovery. By the 22nd October Nobel had founded a company for the manu-

facture of nitro-glycerine. The memorandum and articles of association were as follows:

" Whereas the undersigned have agreed to form a company to be called "The Nitro-glycerine Company," for the purchase of the patent granted to Alfred Nobel, Civil Engineer, by the Board of Trade, on the 15th July of this year, for the manufacture and use of nitro-glycerine, with a view to exploiting such patent in Sweden. The undersigned have arrived at the following agreement to come into effect when the company had been duly formed:

" 1. The total share capital of the company shall consist of 125 shares. Herr Alfred Nobel shall apply for 62 shares, 31 shares of which to be transferred to Herr Immanuel Nobel; Herr Carl Wennerström shall apply for 31 shares; Herr Johan Wilhelm Smitt shall apply for 32 shares; Total, 125 shares.

" 2. Herr Alfred Nobel shall sell to the company the exclusive rights of exploiting the patent referred to above in Sweden, together with any supplementary patents arising out of it, in consideration of the sum of 100,000 reichsthaler, of which amount Herr Nobel has already received 38,000 reichsthaler in cash, the balance of 62,000 reichsthaler being paid in the form of the 62 shares for which he will apply.

" 3. The balance of the share capital, amounting to 25,000 reichsthaler, shall be subscribed by Herr Smitt to the extent of 13,000 reichsthaler, and Herr Wennerström to the extent of 12,000 reichsthaler, on the day when the general meeting, provided for under article 17, is held.

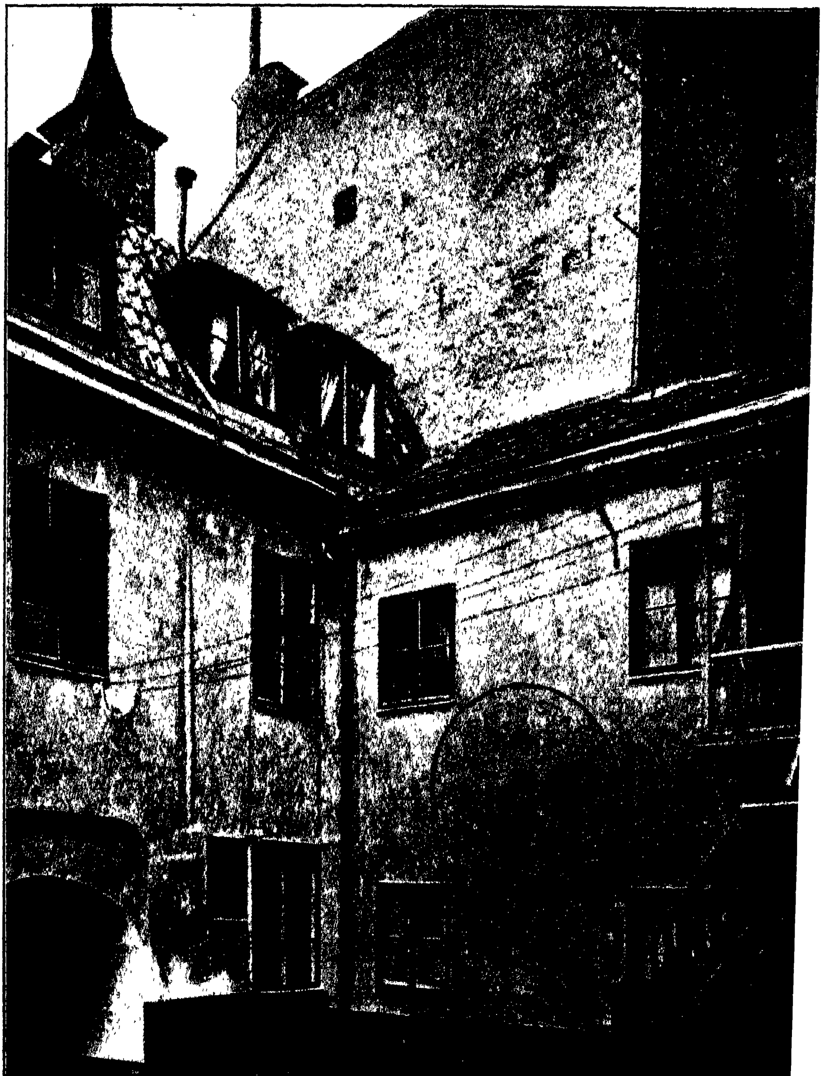
" 4. All materials and instruments collected by Herr Nobel for the manufacture of nitro-glycerine shall be taken over by the company and the expenses incurred in connection with them shall be reimbursed.

" Stockholm, 22nd October, 1864."

Thus Alfred Nobel's profit was not by any means extravagant, amounting to 38,000 kronen cash, and 31 shares, in addition to the 31 shares which he presented to his father. The two other partners, Captain Wennerström and J. W. Smitt, having bought their interest in the company for 38,000 kronen, and deposited the additional 25,000 kronen, only 25,000 kronen was available as working capital for the company. It seems doubtful, however, whether this sum was ever fully paid in cash. It is equally doubtful whether Alfred Nobel ever received the 38,000 kronen referred to in the article. The working capital with which the first nitro-glycerine factory in the world began operations was in fact certainly less than 25,000 kronen. We shall have further occasion to refer to it when describing in detail Alfred Nobel's inventions and their exploitation.

The first general meeting of the company appointed Alfred Nobel, J. W. Smitt and C. Wennerström directors. This was the only meeting attended by Alfred Nobel, and he seems to have sold some of his shares, no doubt because at this time he was in great need of money. In addition, he and his father each gave Robert five shares. At the general meeting of the 28th March, it appeared that Immanuel Nobel held 26 shares, Alfred 19 and Robert 10. And that was the position for some time. Robert now came to Sweden, and was granted a position on quite favourable terms with the Nitro-glycerine Company. He was to receive 10 per cent of the net profits of the company, and a guaranteed income of 500 kronen a month, as well as 1,000 kronen for travelling expenses to Winterwiken. He did not, however, remain long with the company, but, as we have seen, went to Petersburg at the end of 1870 to join his brother Ludwig's business.

Alfred Nobel's connection with the Swedish factory was therefore confined to starting its operations, and he seems to have had comparatively little to do with the running of it. He had bigger



THE HOUSE IN WHICH ALFRED NOBEL WAS BORN

ALFRED NOBEL AT THE AGE OF THIRTY

and wider schemes, being occupied in patenting his invention in all countries, founding companies and setting up factories, as well as—and this was quite as important—endeavouring to make the new explosive less dangerous to handle and therefore of greater practical use. This was accordingly an extremely strenuous time for him, full of successes and disappointments, and, above all, of high endeavour.

Having now attempted to give an outline of Nobel's activities up to about 1864, from such sources as are available, we shall, in some of the following chapters, give an account of all Nobel's discoveries, and of his relations to the companies which he founded.

CHAPTER IV

THE DISCOVERY OF NITRO-GLYCERINE. THE NOBEL FUSE

IN 1833 the chemist Braconnot of Nancy made a discovery which acquired great importance as the first link in a chain of achievements in the field of chemistry and especially of explosives. He discovered that if he dissolved starch or cellulose in strong nitric acid, a new combination was formed which, when precipitated, could be preserved in the form of a white powder. He called the new substance, which, as he discovered, was soluble in ether-alcohol, and which burnt like powder, xyloidin. Another French chemist, Pelouze, produced a similar substance in 1837 by treating cellulose with a very strong solution of nitric acid, which did not destroy the fibrous structure of the cellulose. At the same time he discovered that in certain circumstances a substance was formed which was not soluble in alcohol, and he called that substance pyroxylin.

In 1845 Schönbein, and a few months later Böttger at Frankfort, discovered that a substance similar to that produced by Pelouze and named by Schönbein *schiessbaumwolle* (guncotton) could be more effectively produced by treating cottonwool with a mixture of nitric and sulphuric acid. The attention of experimental chemists and research workers throughout Europe was now directed to this guncotton, its manufacture, its properties and its uses, and especially to the solution of the problem of applying it to firearms as a substitute for the old black powder. For some

time their efforts proved fruitless, since they failed to produce a guncotton that could be kept in a dry state for any length of time without decomposing. After a series of devastating explosions which occurred in various countries during the 'fifties and 'sixties as a result of attempts to store guncotton, it was again discarded. It was not until towards the end of the 'sixties, when Abel demonstrated the reason for the instability of guncotton as manufactured hitherto, and showed how this difficulty could be overcome by running it through cylindrical paper mills and carefully cleansing it, that intensely nitrated guncotton came into use again, especially for military purposes.

Ascanio Sobrero, a young Italian chemist (born the 12th October, 1812),* was engaged as pupil and assistant from 1840 to 1843 in the private laboratory which Professor Pelouze had built in Paris. After working and studying for some months with Justus Liebig at Giessen, Sobrero returned to Turin at the end of 1843, where, in 1845, he fitted up a modest laboratory of his own in the *School of Mechanics and Applied Chemistry*, the laboratory being opened by the *Chamber of Agriculture and Commerce* at Turin, and he was appointed an instructor.

Here Sobrero continued his investigations into the action of nitric acid upon organic substances, in which subject he had been interested by Pelouze, and towards the end of 1846 he succeeded in producing three new combinations of glycerine, sugar and mannite, by treating these substances with nitric and sulphuric acid.

He sent Pelouze a report regarding the first of these discoveries,

* Sobrero had previously studied medicine at Turin University, and in 1834, after passing his examinations, he had been authorised to practise as a doctor. He wished to become a professor of medicine at the university, but failing to achieve his ambition, he decided to devote himself to chemistry instead. The advice of his uncle, Carlo Sobrero, who was director of the cannon foundry at the Turin Arsenal, influenced him in his decision. General Carlo Sobrero, as he was afterwards, became a friend of Berzelius during a stay of some months in Sweden, where he was studying cannon casting at Finspong, which was then regarded as the best works in Europe.

i.e., the production of nitro-glycerine, in a letter written early in February, 1847, which Pelouze published in *L'Institut* on the 15th February, 1847.

In a later report which he handed in to the Academy of Sciences of Turin on the 17th February, 1847, Sobrero described in full detail the process which he used in the manufacture of nitro-glycerine, which he called piroglycerina, as well as the properties of that substance, and his discoveries regarding nitro-mannite and and sugar of milk treated with nitric acid.

Sobrero stated that he produced nitro-glycerine by the following method. He added glycerine which had been rendered as anhydrous as possible, drop by drop, to a mixture which he stirred, consisting of two parts sulphuric acid of the specific gravity of 1.84 and one part nitric acid of the specific gravity of 1.5, maintaining the mixture at a temperature below the freezing point of water. When the chemical reaction was complete he poured the resultant emulsion into water, whereupon the nitro-glycerine separated and sank to the bottom, a heavy oily liquid.

Sobrero had several unpleasant experiences of the explosive properties of nitro-glycerine. He mentions in the report quoted above: "It (nitro-glycerine) disintegrates on being heated. A drop heated on tin plate catches fire and burns briskly. It also has the property of detonating very violently in certain circumstances. On one occasion a small amount of ether solution of pyro-glycerine condensed in a glass bowl. The deposit of pyro-glycerine certainly did not amount to more than two or three centigrammes. When the bowl was heated over a spirit lamp an extremely violent explosion occurred, which shattered it into small fragments. On another occasion a drop was heated in a test tube, and exploded with such violence that the glass splinters cut deep into my face and hands, as well as hurting other people who were standing some distance off in the room. The most effective

way of demonstrating the explosive power of pyro-glycerine is to place a drop on a watch-glass, and cause it to explode with a red-hot platinum needle."

Owing to the explosive properties of nitro-glycerine Sobrero did not succeed in determining its composition. Theoretic considerations, and its similarity to nitro-mannite, led him to the view that it was formed through " the substitution of two equivalents of water, with two equivalents of nitric acid anhydride."

In point of fact, nitro-glycerine is known to consist of glycerine-trinitrate, having the chemical formula $C_3H_5O_3(NO_2)_3$.

Five months later, Sobrero stated in a lecture dealing with his investigations which he gave at a scientific congress in Venice, with regard to nitro-glycerine: " It is not yet possible to say anything as to the use that may one day be found for this liquid substance, which can be exploded by a shock ; future experience alone will show us."

He seems to have had somewhat greater expectations of nitro-mannite—pyro-mannite or explosive mannite as he used to call it—which he hoped would be used for percussion caps. When, however, in 1853, 400 grammes of nitro-mannite exploded in the laboratory of the Turin arsenal through spontaneous combustion, and caused fairly extensive devastation, he seems to have given up the hopes that he had placed in this substance.

When, in the 'sixties, Alfred Nobel found a means for the practical use of nitro-glycerine, Sobrero wished to follow his example, and he attempted in 1873 to found a factory in Tuscany for the manufacture of a kind of dynamite which he called melanine, and which was to consist of nitro-glycerine that had been absorbed by a mixture of powdered charcoal and a kind of natural silicious earth (from Santa Fiora in Tuscany). Sobrero would seem, however, to have had greater gifts as a scientist than as a practical man, and the proposal did not come to anything. On the other hand, he was

shortly afterwards offered the position of consulting scientist by the Swiss-Italian Nobel Company, which had already been formed. He occupied this position, in which he received a generous salary, until his death, after which the company awarded a life pension to his wife. This was not the only way in which Alfred Nobel and his company expressed their regard for this scientific pioneer. In 1879 a bust of Sobrero was unveiled in the company's factory at Avigliana, and this was the occasion of an exchange of letters between Nobel and Sobrero. We quote herewith Alfred Nobel's letter of the 25th May, 1879, which in form and content is equally creditable to both parties, the scientific research worker and the inventor.

" Paris, 25th May, 1879.

" MY DEAR PROFESSOR,—

" You must permit me, in replying to the charming letter which you have just written, to express the admiration and the profound respect with which you have always inspired me. I envy M. Duchène his happy idea of commemorating at Avigliana both the great discovery which the world owes to you, and the lineaments of the author of it.

" I hope soon to have the pleasure of calling on you in Turin. Meanwhile, believe me, with kind regards,

" Yours very sincerely,

" A. NOBEL.

" M. R. Sobrero,
" Commander, Professor and Life Secretary at the Academy of Sciences, Turin."

' Paris, le 25 Mai, 1879.

' Cher Monsieur et Professeur,—

" Permettez moi de réitérer a l'occasion de la lettre charmante que vour venez de m'écrire l'expression de l'admiration et du profond

respect que vous m'avez toujours inspiré. J'envie à Mr. Duchène l'heureuse idée qu'il à eu de commemorer a Avigliana et la grande découverte que le monde vous doit et les traits si sympathetiques de celui qui en est l'auteur.

" J'espère avoir bientot le plaisir de vous présenter mes respects at Turin. En attendant veuillez agrer l'expression de mes meilleurs sentiments et l'assurance de mon parfait dévouement.

" A. Nobel.

" Mr. A. Sobrero,

" Commandeur, Professeur, et Secrétaire, perpetuel a l'Academie des Sciences, a Turin."

A sample of a few hundred grammes of nitro-glycerine, manufactured by Sobrero in 1847, is still preserved in the factory at Avigliana, to which Sobrero himself presented it when he resigned his position as professor. His successor was nervous about keeping the dangerous liquid in the laboratory.

For about fifteen years after Sobrero's first discovery, nitro-glycerine continued to be regarded as a kind of scientific curiosity, which, on account of its dangerous qualities, was regarded as almost taboo for practical purposes.

During these years nitro-glycerine's only use, a very limited one, was for medical purposes. Both Sobrero, and later, J. E. de Vrij, professor of chemistry in a medical institute in Rotterdam, had made more detailed investigations into its physical effect,* and their experience led, especially in America, to the introduction of nitro-glycerine as a medicine, under the name of glonoine, the nitro-glycerine being sold in weak solution in alcohol. Nobody during this period, however, seems to have broached the problem of the use of nitro-glycerine as an explosive, for apart from the

* The latter lost his eyesight for some time as a result of an explosion during the manufacture of nitro-glycerine.

obvious dangers of handling the stuff, its fluid nature, and the difficulty of producing an explosion by any practical and reliable means, made the matter more difficult.

The old black powder, the only explosive hitherto used in practice, could be caused to explode with comparative ease and security by means of a fuse. This was also the case with dry guncotton, a fact which partially explains the keen interest aroused by its first appearance. Nitro-glycerine, however, could not be caused to explode by this means. If lit, a small quantity would burn with a flame, and it was only if the whole quantity was enclosed or heated at once that the combustion could be transformed into an explosion, while an explosion could also be produced by a sharp blow, or by rubbing the substance between two hard surfaces. Practical means, however, for producing these conditions for an explosion were unknown.

Meanwhile, as Alfred Nobel himself tells us, two Russian chemists, Professors Sinin and Trapp, of Petersburg, had directed Immanuel and Alfred Nobel's attention to the possibilities of nitro-glycerine as a practical and powerful explosive. The idea seems to have arisen during the Crimean War, when Immanuel Nobel was well on the way to perfecting his submarine mines, for which purpose he required a more effective explosive than black powder. It is true that the first attempts made by Immanuel Nobel were unsuccessful, and the matter was shelved until he took it up again in Sweden, in 1862 or 1863. At that time he thought that he had discovered an excellent new powder by adding 10 per cent of nitro-glycerine to ordinary black powder, and that the mixture could be used both in firearms and for blasting purposes. According to the elder Nobel's somewhat optimistic calculations, this mixture achieved the same effect with a charge of half the ordinary weight, while the fouling of the gun was reduced to one-fifteenth. Immanuel Nobel succeeded in interesting

the military authorities in Sweden in his new powder, and they spent 6,000 kronen to enable him, with the assistance of Alfred, to carry out experiments at Karlsborg.* The results, however, were not very satisfactory, for it proved that the powder was not very well adapted to loading firearms, and that in the circumstances of the time, that is, when fired in the usual way, this mixture of black powder and nitro-glycerine produced a sensibly more powerful explosion only when the mixture was fresh. If the mixture was some hours old, so that the nitro-glycerine was fully absorbed by the pores of the gunpowder, the mixture became less active, and the combustion was slow. It did not appear, therefore, from its behaviour on this occasion, to be of any direct practical use.†

Meanwhile his father's experiments had given Alfred Nobel an idea of another method of applying nitro-glycerine. The connection between Immanuel's and Alfred's inventive achievements is shown in this case by the letter from Alfred to his father, quoted above. (The letter is not dated, but was probably written in May, 1864.)

As early as May or June, 1862, Alfred, as has been stated, had carried out some preliminary explosive experiments under water, with a small amount of nitro-glycerine. He had poured nitro-glycerine into a glass tube, which he had stoppered firmly, and then placed it in a metal tube filled with gunpowder. The outer tube was stoppered at both ends, and a fuse was introduced into the powder. He lit the fuse and threw the whole contraption into a canal, whereupon a sharp explosion and a substantial water-spout, hurled upwards, showed that the nitro-glycerine had been completely exploded.

Alfred further worked out the idea underlying this experiment,

* A Swedish fortress.

† It is true that Alfred Nobel succeeded at the Karlborg experiments in producing a magnificent explosion with a cast-iron bomb, which was loaded half with compressed gunpowder and half with nitro-glycerine. It was, however, obviously far too dangerous to use bombs loaded in this manner for shooting.

i.e., the application of a special detonating charge to cause the nitro-glycerine to explode. Instead of making the charge, which always consisted of black powder, surround the nitro-glycerine, he applied it above or below. He also hit upon the idea of enclosing the black powder in a small glass tube, which he placed in the explosive liquid, and fired with a fuse. These experiments, which were carried out at Heleneborg, were at first unsuccessful, until Alfred discovered that it was necessary to seal the opening to the glass tube. This was the principle of Nobel's "Patent Detonator," and applies generally to all special detonating charges used for producing the explosion of materials which will not explode by simple firing.

The direct development of this idea, which revolutionised the whole technique of explosives, is clearly revealed by Alfred Nobel's first Swedish patent, of the years 1863 to 1867.*

A written narrative in the form of a cross-examination, conducted by Alfred Nobel's American lawyer Rix, in 1874, is highly informative regarding Immanuel and Alfred Nobel's first attempts with various methods for igniting nitro-glycerine, as well as regarding the manner in which Alfred's special "igniter," and finally dynamite itself, came to be discovered. This statement was taken in connection with a patent dispute in the United States, and a copy has been preserved in the archives of the Nobel Foundation (see Appendix IV), as well as a previous statement made in Hamburg in January, 1866, in connection with a patent dispute with Colonel Shaffner (see Appendix V). Finally Alfred's letter written in 1864 to his father, which has been quoted above, gives information on many points.

Alfred Nobel's earlier view was that nitro-glycerine could be caused to explode completely only by heating rapidly the whole

* Swedish pat. 14.10.1863. See App. III. Application for Swedish pat. not proceeded with. 4.5.1864. Swedish pat. (10.6.) 15.9.1864. Swedish pat. 19.9.1867.

mass to the detonating temperature (170° to 180° C.). In his first application for a patent of 1863, which deals with the use of nitro-glycerine as an addition to ordinary powder, he states accordingly that the essential point of his discovery is that "nitro-glycerine is heated by powder gases to the temperature at which it will explode." In the application of the 4th May, 1864, which he dropped, as well as in his application of the 10th June of that year, on which the patent of the 15th October, 1864, was granted, Nobel describes his detonating charges filled with black powder. In the latter application he states amongst other things: "The process described in my application of the 14th October, 1863, of mixing powder with nitro-glycerine or some similar substance, has for its main object the sudden heating of that substance to the temperature at which it will explode. Since then, theoretical reasons have led me to the conclusion that if the heat of the powder can be communicated to the nitro-glycerine with the speed necessary to induce an explosion, the still greater heat developed by the nitro-glycerine through the blow and the pressure of the gases that have formed, should assist it in its explosion."

According to this theory a sufficiently powerful explosive impulse delivered to one definite portion of the explosive material would be sufficient to induce the explosion of the whole. Apart from the detonating charge mentioned above, various methods are described for producing such a partial impulse, and amongst others, the use of percussion caps is mentioned. The main idea developed from this point was certainly still that of producing a local rise of temperature such as would be sufficient to start the explosion, but he showed now also a certain realisation of the importance of a definite initial impulse or priming in order to produce a full explosion, in the sense in which we understand it to-day. Nobel states: "I therefore lay claim to (1) the idea so far as industrial use is concerned, of contriving, by administering a mere initial impulse,

to develop an explosion in such substances as can, when exposed in the open air, be brought into contact with burning bodies without exploding. . . ."

When Nobel began to make practical use of nitroglycerine that had been absorbed by porous solid substances (dynamite) he found it necessary to make the primary charge more powerful. His application of the 19th September, 1867, which was granted on the 12th October, contained the following claim: "(2) the method of detonating the powder in question, or dynamite, by means of percussion caps, powder or other explosives, enclosed in cases, that produce a powerful local detonation or a blow of the necessary violence."

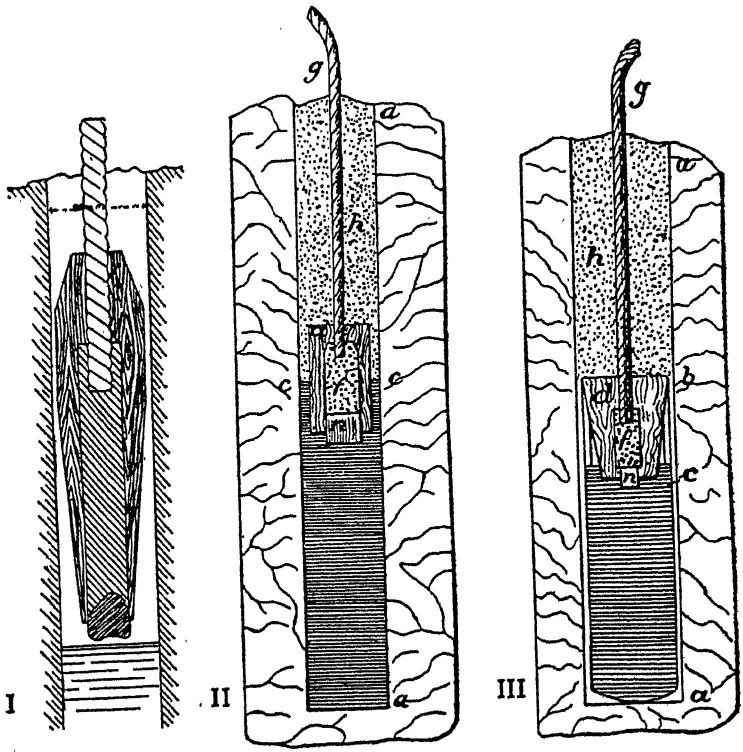
His letters of this period also show that Nobel already had a definite conception of the effect of the primary charge upon the course of the explosion and the rapidity of detonation, and also perceived the problems which were not finally solved or explained until a much later period.

As has been stated, Nobel first used black powder for his primary charge, then black powder together with fulminate of mercury, and finally fulminate of mercury alone.

In actual practice the methods of detonating charges of nitroglycerine varied considerably during the first years of their frequent use, as is shown by a pamphlet published in 1866 by the Nitroglycerine Company in Stockholm under the title, "Regarding Nitro-glycerine, Nobel's Patent Explosive Oil," which pamphlet gave instructions for its use. The construction of "Nobel's Patent Detonator" also went through a series of developments. At first it consisted of a small wooden cylinder open at one end and with a hole in the base large enough to allow the insertion of the fuse (see sketches 1 to 3).

The cavity of the cylinder was filled with fine black powder, whereupon the opening was closed with a cork or stopper. By

means of the fuse, the charge was then pushed some way into the nitro-glycerine, after which the bore was filled with a packing of sand. When Nobel began to use charges of fulminate of mercury



NOBEL DETONATORS

Fig. 1. Earlier type. Fig. 2. Later type (inserted into a bore-hole charged with nitro-glycerine). Fig. 3. Cartridge for nitro-glycerine with fuse inserted: (*a*) surrounding rock; (*b*) soft coating; (*c*) nitro-glycerine charge; (*d*) wooden case for detonating charge; (*f*) charge of black powder in detonator; (*g*) fuse to detonator; (*h*) packing.

(*Note.*—The letter (*e*) is omitted.)

instead, he first had recourse to small lead capsules, and then used the copper detonators which are still in general use. In his English patent No. 1345 of the 7th May, 1867, Nobel gives a

somewhat more detailed description of these fulminate of mercury capsules. Professor Will, the eminent German research worker in explosives, said in 1904 in the course of a lecture on the development of the science of explosives: "This invention, whereby the fulminate of mercury is used as a detonating charge for nitroglycerine and guncotton (and we could mention a whole series of other materials as well), so that their explosive energy is released at will, has repeatedly been characterised as constituting the greatest advance in the field of explosives since the discovery of gunpowder. But for this invention it would not be possible to use these substances for explosive purposes at all, while it is also due entirely to this invention that we have been able to discover and exploit the explosive properties of a whole series of other substances."

In the popular mind, Alfred Nobel is esteemed as the discoverer of dynamite; but in actual fact his invention of explosive capsules and detonating charges for high explosives should be ranked in importance, both from the purely inventive standpoint and from the point of view of its technical importance and significance, decisively above the invention of dynamite.

CHAPTER V

THE EARLY EXPLOITATION OF THE DISCOVERY OF NITRO-GLYCERINE, KIESELGUHR DYNAMITE

THE first laboratory for the manufacture of nitro-glycerine for technical purposes was, as has already been mentioned, set up by the two Nobels, probably in the autumn of 1863, in a building close to Immanuel Nobel's house at Heleneborg near Stockholm. The explosion which occurred there on the 3rd of September, 1864, caused the loss of five lives, one of those killed being Alfred Nobel's younger, and exceptionally gifted brother, Emil. This disaster naturally caused an enormous sensation, and infected the general public with the greatest terror of the new explosive, which had hitherto been regarded as comparatively harmless. The elder Nobel had not considered it necessary to notify the authorities that he was making this substance, and the extent to which he shared the general view as to its harmlessness is indicated by the statement which he made to the police after the explosion. The following is an extract from his statement:

"As none of those who were taking part in the production of explosive oil or nitro-glycerine survived the explosion, it is of course impossible to give any full explanation of its cause. I can only infer from some remarks made by my dead son before the disaster, that the explosion was due to an attempt he made to simplify the method of producing explosive oil.

"Since nitro-glycerine is harmless, even if lit, and the greatest

carelessness in the use of fire is hardly able to produce an explosion, and since there cannot have been any fire in the laboratory, the only possible explanation that remains is that the experiment made by my son produced a violent reaction which raised the temperature of the mixture to the heat (approximately 180 degrees Celsius), at which fully formed nitro-glycerine will explode.

" The fact that in a new experiment no thermometer was used to note the temperature, and see that it did not rise too high, is therefore the real cause of the disaster.

" This need not happen in the normal process of manufacturing the product, which may be done in one of two ways:

" 1. By the so-called warm method, in which the temperature rises to about 60 degrees Celsius and never higher. This method has been used hundreds of times without the slightest risk attached to it.

" 2. By the cold method, in which the temperature is not allowed to rise above freezing point, and therefore no danger can ensue.

" The reason why I did not arrange for the stuff to be manufactured outside the town area was that under normal conditions there was really no possibility of risk, for the following reasons:

" (*a*) Because nitro-glycerine can be lit without exploding, and burns like an oil, but with less danger, since it goes out of its own accord.

" (*b*) Because I have tried heating it in fairly large quantities in a glass container in order to see the effect, and have found that even then only a small portion of it explodes, the rest being scattered.

" (*c*) Because it is in fact exceedingly difficult to produce a total explosion unless it be directly heated to 180 degrees Celsius in a very strong container, as has been shown by a large number

of blasting operations, in which the charge failed to detonate, the problem not having been fully worked out.

"The amount of explosive oil which had been fully manufactured when the explosion occurred, and which was to have been sent off that very day (fifty pounds to Ammeberg and two hundred pounds to the Northern Main Railway) amounted to about three hundred pounds; but the nature of the explosion clearly proved that a small proportion only of this amount actually exploded, the rest having been scattered unburnt. The reason why the manufacture of explosive oil was not notified was that until the last few days it was being made only in very small quantities, and more with the object of perfecting the process than for trade purposes, as is indicated by the fact that no advertisements were inserted in the press.

"In order to avoid any misunderstanding I should add that the refining of glycerine, on which I assume my son to have been engaged when the accident occurred, need have no connection whatever with the manufacture of nitro-glycerine; such refining can be carried out in the same factory as that in which glycerine is made, and an accident is as unlikely to occur in that case as in the manufacture of nitro-glycerine.

"Heleneborg, 5th September, 1864."

This sanguine attitude regarding the comparative harmlessness of nitro-glycerine and its manufacture maintained by Immanuel Nobel, in spite of the disaster which, as we have seen, destroyed his health and energy, was naturally not shared by the authorities and public opinion.

Its manufacture was prohibited within the city area, and it proved to be exceedingly difficult to find a suitable site for its manufacture in the neighbourhood. Now as "explosive oil," as we shall soon see, was already in practical use, for the tunnelling

operations of the State Railway line, terminating at Stockholm, and for other purposes, its manufacture had to be improvised in some way or another. This was the immediate task to be carried out by Alfred Nobel, and by the Nitro-glycerine Company founded by him, together with his father and others. The problem was solved by transferring the manufacture to a pontoon, anchored in the Malar Lake, a couple of miles from Stockholm. Nitro-glycerine was manufactured there in the late autumn of 1864 and during the following winter, until a new site had been acquired at Winterwik, near Stockholm, where the first real nitro-glycerine factory in the world was built, and to which the manufacture of nitro-glycerine was transferred in March, 1865.

The principle applied by Alfred Nobel for the production of nitro-glycerine was the same as that still used in the explosive industry, and had already been worked out by Sobrero ; namely, the treatment of glycerine with a cooled mixture of sulphuric and nitric acid. The simplest conceivable apparatus was at first used in practical manufacture on a large scale.

The nitrification was produced, as is indicated in Immanuel Nobel's statement quoted above, either by the so-called "warm method" or by the "cold method." In the former case the acids, which had been previously cooled, were allowed to flow, together with the glycerine, into a glass container, considerable heat being developed by the resulting chemical action ; the mixture was then poured straight into water, whereupon the new substance, nitro-glycerine, sank to the bottom. The yield derived from this method was, however, generally very inconsiderable.

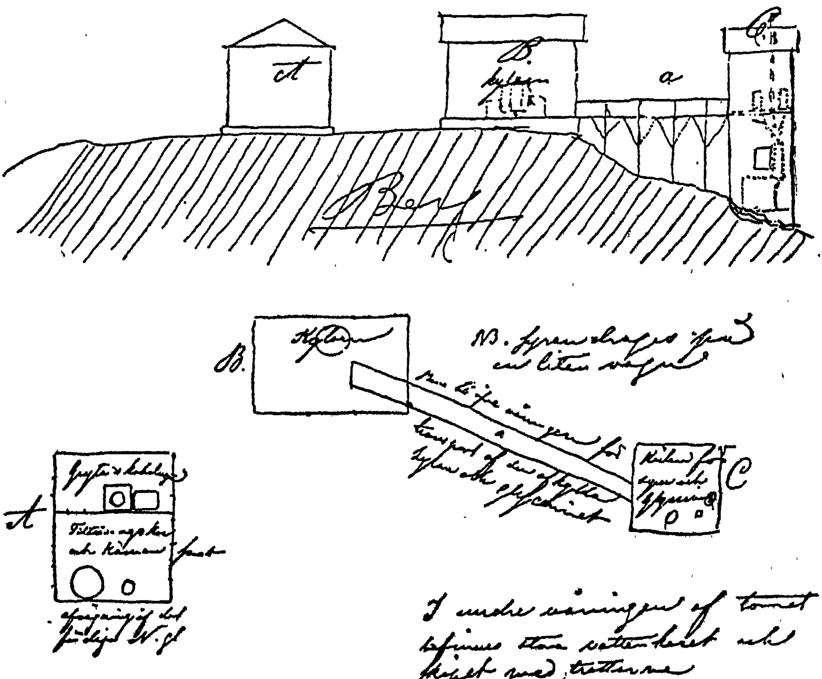
A somewhat better result was achieved by the "cold method," in which glycerine was gradually added in small amounts to the mixture of acids, the latter having been first cooled with ice, and also after each infusion of glycerine. It is clear, however, that this process at first involved some difficulty.

We get a good idea of the simplicity of the first nitro-glycerine factory from a letter dated the 30th August, 1865, which Robert Nobel wrote from Helsingfors, to Captain Wennerström (who was then the manager of the Nitro-glycerine Company in Stockholm), describing his factory near Fredriksberg, which had been modelled on the factory at Winterwik. The following is an extract from the letter:

"Helsingfors and Fredriksberg, 30th August, 1865.

"To Captain Carl Wennerström, Stockholm.

" . . . fortunately I have no machinery in the factory; the manufacture is carried out in three separate buildings, as is shown by the rough sketch given below.



"Everything went off entirely satisfactorily at the test, but I am particularly pleased with the cooler, in which I can maintain a temperature of fifteen degrees without any difficulty. It is constructed in the following manner:

"It differs only in its base from the one which I saw at H. H.'s in Stockholm, but that is just wherein its great convenience consists. As you will see, the floor of the lead cistern is completely exposed to the air, so that no ice can form near the tap, while any ice that might possibly form in that small portion of the container which rests upon the base of the barrel, cannot slip through the conduit pipe, because of the special loose ring attachment and the fine sieve at the exit. Drawing off the mixture below by means of the tap very much facilitates the work and has no disadvantages.

"This cooler has suggested a new idea to me for production by the cold method, but this idea must stand over until I have recovered the expenses of the apparatus I have already installed, as I have no penchant for experiments.

"Alfred is much in favour of production by the cold method, as being both safer and more profitable, and after various experiments I have come to the same conclusion.

"I am, Captain Wennerström, yours, etc.,

"Robert Nobel."

A memorandum also written in Robert Nobel's handwriting gives a more detailed account of the nitric acid process; having a certain historic interest, this memorandum is quoted in the appendices (Appendix VI).

With such simple apparatus, the yield of nitro-glycerine was occasionally somewhat poor. In a letter to Alfred, dated the 13th October, 1865, Robert bitterly complains of the "nitric acid from Hamburg, which by the cold method had yielded only one pound

of nitro-glycerine to six and a half pounds of acid mixture, while by the warm method, through funnels, I have had such poor results that I could not proceed. I have used much more glycerine than I ought to have done, but I imagine that the glycerine was too cold when it was being poured." He is generally "dissatisfied with the funnel method," and would like to come "on a flying visit" to Alfred at Krümmel to see how his brother has arranged things.

Gradually the Nobel factories entirely adopted the cold method, which was improved by degrees, by introducing the method of continuously cooling the acid mixture by means of pipes containing cold water, by adding the glycerine in a continuous thin stream, and by separating the nitro-glycerine from the acid mixture after the operation had been completed, thus preserving the residue of acid for further use. These improvements were, however, only gradually achieved, and in many cases they were dearly bought at the expense of the explosions which occurred in experiments with new apparatus of various kinds.

At the start the price of nitro-glycerine continued to be comparatively high (in Sweden 2.5 kronen a pound, in Finland 1.4 roubles, in U.S.A. 1.25 dollars). But the considerable saving of labour involved in blasting operations enabled the new explosive to come into general use fairly quickly.

It would appear that nitro-glycerine was first used for real blasting operations in the summer of 1863, for blasting granite at Huvudsta, and at the Tyskbagareberg in Stockholm, as well as for blasting felspar at Stora Rösholmen. In mining nitro-glycerine was first used experimentally at Ammeberg in December, 1863. Early in 1864, Alfred was in correspondence with the head of the concern there at the time, Herr Schwartzmann, who had shown a certain interest in the idea of carrying out more extensive experiments with the new explosive in the mines. For one reason or another,

however, probably because of difficulties of transport, it seems to have been some time before nitro-glycerine could be delivered in the considerable quantities required for the purpose.* In any case during the summer of 1864, trial blasting operations were conducted in the Dannemora, Vigelsbo and Herräng mines, and in October of the same year the explosive was used in the tunnelling operations under Sœdermalm to complete the last section of the Southern Railway into Stockholm. By the middle of May, 1865, nitro-glycerine was being used in the Bersbo mine (near Atvidabarg), and by the end of the year 314 pounds had been used there. During 1864 and the beginning of 1865, Alfred had taken over the direction of everything concerning tests, production and exploitation of the new explosive in Sweden. When the Nitro-glycerine Company was formed he seems at first to have been simultaneously managing director, production manager, chief clerk and cashier. The company's first cash-book was kept by him personally in the autumn of 1864. In spite of the heavy blow that had descended upon the family through the explosion at Heleneborg, he maintained his faith in his discovery and its future with admirable courage. He soon felt that the time had come to seek a wider field for its exploitation, and in the spring of 1865 he accordingly went to Germany, where, in Hamburg, he succeeded in securing two partners and financiers, the Swedish merchant, W. Winkler, and Bandmann, a lawyer. On the 20th June, 1865, the firm of Alfred Nobel and Company was entered in the trade register of Hamburg. Under the name *Dynamit-Aktien-Gesellschaft vormals Alfred Nobel & Co.* this undertaking still holds a leading position in the general explosives industry of Germany, as is indeed the case with all the dynamite companies founded by Nobel in various countries. During the first experimental efforts in Germany, it is probable

* The correspondence, which was carried on in French, has a certain interest, and some of the letters are given in Appendix VII.

that small quantities only of nitro-glycerine were produced at Hamburg by Nobel, probably rather on the lines of ordinary laboratory work, and presumably in one of Winkler's warehouses; but on the 8th November, 1865, permission was granted to build a nitro-glycerine factory at Krümmel on the Elbe, some miles above Hamburg.

The document granting the license has a certain historical interest, and deserves to be recorded. It has been extracted from a commemorative pamphlet published in 1925 to mark the sixtieth anniversary of the company.

"The reports of the court at Gulzow and of the medical officer, Dr. Völcker, having been considered, permission is hereby granted to the manufacturer, Alfred Bernhard Nobel, in Hamburg, in accordance with his application of the 24th September of this year, to set up a chemical factory for the production of explosive oil called Nitro-Glycerine at Krümmel in the Gulzow district, subject to the following conditions:

"1. The site of the factory and of any buildings destined for warehousing the products shall be subject to the control of the buildings police, who shall be guided especially by the following considerations: that the proposed buildings shall be erected at a suitable distance from any dwelling house, that the factory and other buildings shall be surrounded on all sides, including that facing the river Elbe, with a natural or artificial rampart of earth which shall be at least fifteen feet high and twenty feet broad at its base, and which shall be properly strengthened, or its height increased if the manufacture of nitro-glycerine is carried out, not in the ground floor of the building, but in upper stories.

"2. The rooms in which percussion caps are manufactured or stored are to be separate from the rooms in which nitro-glycerine is manufactured and stored.

"3. The internal arrangements of the factory and of the

buildings appertaining to it, and the whole management of the factory, shall likewise be subject to the control of the local authorities, and the owner of the factory shall obey any present or future police regulations regarding the conduct of the factory.

"4. It shall be the duty of the owner of the factory in the conduct thereof, to guard against anything prejudicial to the health of the workmen, and he shall be liable for any damage arising from the building of the factory and its working. A further communication will be sent regarding the security to be deposited in respect of this industry.

"The two enclosures sent with the application are returned.

"Resol. Ratzeburg, the 8th November, 1865.

"Königl. Preuss. Herzogl. Lauenb. Regierung."

Early in 1866 W. Winkler's brother Theodor joined the company as chief accountant and as a partner; he devoted himself with the greatest enthusiasm to his work, and to carrying the undertaking over its first difficult years. He seems also, possibly jointly with his brother, to have owned the felspar quarries at Stora Rösholmen, and to have learnt the use of nitro-glycerine there in 1863.

From the beginning of 1866, the Hamburg factory was delivering nitro-glycerine, not only to various parts of Germany and Austria, but also to other countries, such as Belgium, England, the United States, and Australia. At this time little was known regarding the properties of the new explosive, and an entirely wrong impression was current regarding its harmlessness. The explosive oil was consigned in zinc cans, which were placed in wooden crates. These crates were at first stuffed with shavings from sawmills, and later with kieselguhr (a kind of porous clay consisting principally of silicates, with a high absorption capacity, this clay being common in north Germany). As in the early days, the nitro-glycerine

was not fully free of acids, the liquid often ate holes into the cans on long journeys, and ran out. Explosive experts of the present day cannot read the accounts of this period without shuddering; many of them have a touch of grim American humour. In north Germany nitro-glycerine was at first often carried in such tin cans for considerable distances, on rough two-wheeled carts, and when the cans began to leak if often happened that the oil trickled over the wheels, and during the winter it might even freeze to ice. These cans were also sometimes sealed without being properly cleaned; and on one occasion when the wheels of the carts began to squeak unduly, nitro-glycerine was actually applied as a lubricating oil! The following incident shows how little anybody at first appreciated the real dangers connected with the handling of nitro-glycerine. When Captain Wennerström was on his way to Norway, in 1865, to introduce the new invention into that country, he took bottles of nitro-glycerine as samples. He took these samples with him in a travelling bag on various journeys to places where blasting experiments had been arranged. The explosive oil, not being wholly purified, would begin to ferment (the first stage of decomposition), with the consequence that the resulting gases blew out the cork, and much of the nitro-glycerine was lost.

The Swedish sapper officer, Cl. Adelsköld, gives an exceedingly humorous account in his memoirs of the manner in which nitro-glycerine was treated in the early days. He relates how he read in the newspapers about Nobel's invention of a new explosive, during the summer of 1864, how he got into touch with him, and arranged experimental blasting operations in connection with the projected railway line between Köping and Uttersberg. Robert Nobel arrived at Köping with twelve bottles of nitro-glycerine, and the experiments were duly carried out (this cannot have been before 1866, when Robert returned to Sweden). Of the twelve bottles,

ten were used in one week in experiments. "The really extraordinary thing," says Adelsköld, "and what I find more and more incomprehensible each day of my life, is that during those six days we did not blow ourselves up into atoms fifty times a day. The old proverb has certainly proved true, 'the Lord is the fool's guardian.'

"That is how we used ten of the twelve bottles, which Nobel brought with him to Köping, and when we parted, after a highly interesting and delightful time together, he left the two remaining bottles with me, to carry out experiments on my own account. In order that my engineers in Schonen might enjoy the fun of being present, I put the bottles into a box and took them with me when I went to Kristianstad (in south Sweden).

"The railway between Jönköening and Alvasta had not yet been opened, so that I had to travel that section by post. A pleasant and amusing lady of Schonen, whose name I cannot remember, was travelling in the same coach, the case with the two bottles of explosives having been put up on the box.

"So we travelled through the night, joking and laughing, with death over our heads. When we arrived at Alvesta it appeared that one of the bottles had been broken by the jolting, and its contents had trickled over the side of the carriage and the wheels. The other bottle strangely enough survived the coachman hurling the box from the top of the coach on to the hard ground, and I took it with me by train to Kristianstad. A few days later several of the engineers on my railway came together; the experiment was to be carried out, but nobody could find the bottle, which had been put in the kitchen. My own woodcutter Holmquist, who also was my factotum, believing that the bottle had contained grease, had used the nitro-glycerine for oiling his boots and breeches and my reins. He had put the what was left in a corner of the woodshed. When I had discovered the remains of the last bottle of the dozen, I got a man to bore a hole in a large rock of several

cubic metres embedded in the earth. The remaining nitro-glycerine was poured into the hole, the fuse was inserted and the charge was laid, not in the way that was in general use later with a packing of sand, but in the manner of the old powder charges with crushed bricks, which were rammed down with an iron rod.

"Human foolishness had not yet been too much for divine forbearance, but when the fuse which had been severed in the loading operation failed to ignite the charge and the bore-hole had to be reopened for a new charge, that settled it, and the nitro-glycerine duly exploded to such good effect that the rock burst into a hundred pieces that buzzed past our heads like giant hornets. The surprised workman who had laughed at the 'sour milk' when the nitro-glycerine was poured into the bore-hole was blown sky high, but came to earth again splayed out but undamaged."

The ignorance of the risk involved in handling this substance soon bore fruit. From various parts of the world news came in of devastating explosions. A Hamburg newspaper of the 4th December, 1865, contains the detailed account of such an explosion in New York. A German traveller had brought a flask containing ten pounds of nitro-glycerine carefully packed in a box to a small hotel called the Wyoming Hotel in the Greenwich district of New York, and had left it intending to call for it again. The porter was looking after the flask and using it sometimes as a seat and sometimes as a footrest for bootblacking. One fine Sunday morning a waiter noticed that a red vapour was issuing from the box. The porter carried it out into the street and then returned to the hotel. A moment later a terrible explosion occurred; the fronts of the neighbouring houses were seriously damaged, doors and windows were shattered, and the roadway was rent to a depth of four feet.

On the 3rd April, 1866, a violent explosion occurred off Aspinwall on the Atlantic coast of Panama, which completely destroyed the

steamer *European.* She was carrying a cargo of nitro-glycerine in addition to other munitions, which were to be sent across the isthmus of Panama to the Pacific Ocean. This accident caused the loss of seventy-four lives besides considerable material damage. A little later in the same month another consignment of nitro-glycerine exploded which had been carried the same way by boat to San Francisco. This explosion occurred in Wells, Fargo & Co.'s warehouse, which was destroyed with the loss of fourteen lives. A little earlier (on the 4th March, 1866) another serious explosion had occurred at Sydney in Australia, which completely obliterated a warehouse in which two cases of nitro-glycerine had been stored, and caused several neighbouring houses to collapse. The data regarding the loss of life in this explosion are conflicting. The Krümmel factory itself was destroyed by an explosion early in May, 1866.

This series of disasters naturally caused an enormous sensation, and the public were highly suspicious and quite terrified of the new explosive. In several countries the authorities felt it necessary either entirely to prohibit the manufacture or possession of nitro-glycerine, as was done in France and Belgium, or, as was done in Sweden, to prohibit its transport (by a royal decree of the 24th July, 1868). In most countries the carriage of nitro-glycerine by rail was prohibited, while in some, as in England, the handling and use of the substance was made subject to such strict regulations as in practice to amount to prohibition.

It is said that Sobrero was so much upset by all these accidents that he bitterly lamented that he had ever come to make this dangerous substance.

Alfred naturally received appeals from all quarters. On the one hand these events had terrified those whom he had succeeded in interesting in the exploitation of his discoveries, and on the other hand he enjoyed the reputation of being the only person who

could surmount the difficulties connected with the new explosive, and make its great advantages practicable for industry. Both attitudes of mind are well illustrated by a letter from Julius Bandmann, the San Francisco agent of Alfred Nobel & Co., and the brother of Nobel's Hamburg partner, Dr. Bandmann. This letter, having a certain technical and historical interest, is quoted in Appendix VIII. The writer begins by pointing out that the hope of introducing the new explosive had been abandoned for the present owing to the numerous and disastrous accidents. He said that a sour smell had been noticed on opening the chests containing the nitro-glycerine, and also that when the bottles were uncorked, heavy gases were given off, and it was observed that a brownish froth had formed on the surface of the nitro-glycerine. Bandmann desired an explanation of these phenomena, and to be told to what extent they should be regarded as dangerous. A number of cans containing nitro-glycerine had started leaking in the course of transport, and some of them had actually arrived empty, so that they had hit upon the idea of bottling the explosive oil in empty champagne bottles, and as nobody would store these in the town, they had had to put them on a punt, which Nielsen, one of the partners, had succeeded, with the assistance of a few Chinese, in taking to the bay of San Francisco, three English miles from the city. The writer went on to say that Nobel was the only person who could restore confidence in nitro-glycerine; and that Nobel must accordingly proceed at once to California, which offered the greatest market in the world for the new explosive. He said that three to seven hundred tons of powder were used in a single blasting operation, so that the advantage of substituting nitro-glycerine would be enormous. But it was essential to arrange for the stuff to be manufactured on the spot in order to avoid the danger of transporting it to the Equator and across the Isthmus of Panama.

The following letter from T. Winkler, sent from Hamburg on the 3rd May, 1866, gives a very good idea of the situation :

"Hamburg, 3rd May, 1866.

"My Dear Alfred,

"I need not tell you what a storm has descended about our ears, as the result of the various accidents that have occurred. You can well imagine it. In the course of a couple of days the events at Aspinwall, San Francisco and here have excited people to such an extent that I feared we should not be able to transport a single can of oil before people had calmed down.

"It is at the moment absolutely impossible to send consignments to Belgium and England, or indeed, to send any consignment from Hamburg. The load of 1,250 pounds which was on its way to London has been prohibited, and that idiot, Cusel (the agent in London), cannot make up his mind whether to send the consignment back, or to throw it into the sea—in a word, according to the latest news, the difficulties have increased to such an extent that it is no laughing matter at all, and I must proceed very cautiously or we shall run the risk of getting into financial difficulties.

"For this reason I have asked Rosen not to travel to Paris until everything, including the political situation, is more favourable. I have asked Cusel to arrange with Wood Cooper to terminate the travelling expenses allowance, as we cannot send any oil for the time being. I am stopping the production of oil, as we have ten thousand pounds on hand, and I am making every effort to cut down expenses, so that we may be in a position to weather this crisis which, like everything in this world, must be given time to work itself out. As for the future, we must wait and see; I shall continue to hope, and indeed I believe that all will be well if only we have the means to overcome these difficulties and to make good

this loss of time. I am more anxious than ever that you will be able to carry through this business of the company, and that you will soon come back with several thousand dollars in your pocket, for with money everything is possible.

"As you may imagine, these accidents have been a serious blow to our negotiations with Austria, England, etc. My main hope of soon making a large profit out of our oil is based on the fact that the Austrian War Minister is considering it in connection with the defence fortifications, and I shall probably soon be going to Vienna again on this matter.

"I do not know how you have got on in New York. You might have written me a line during the eight days you were there. I beg you to return as speedily as possible, unless you think that the prospects of the company in New York are seriously worth considering. Do not waste any time there, for as things are it will be much more profitably spent here, since in my opinion the situation is such that we must at all costs send a request to the various great powers, asking the governments to appoint a commission of experts to examine our oil, and to lay down definite rules and regulations for the transport and handling of the product, so that the trade in it can be legally regularised. Until this is done we shall just be peddling inefficiently.

"I enclose a newspaper cutting and a letter from your old father. Being on the spot, I expect you have full details of the disaster at Aspinwall and San Francisco, so I am not sending you anything about them.

"Hoping that these dark days will soon pass, and that there are better times ahead,

I am,

"Yours ever,

"THEODOR WINKLER."

As this letter indicates, Alfred Nobel was then in the United States, whither he had gone from England in April, 1866. His letters show that the disasters profoundly moved him, but he lost neither his courage nor his faith in the future of his inventions and their great possibilities for mankind. In spite of all his business worries, his disputes over patents, and the accumulating difficulties of all kinds, he concentrated all his inventive gifts upon the problem of discovering a means of finding a safe method of transporting nitro-glycerine. At first he believed that he had found a satisfactory solution by adding a non-explosive solvent such as methyl alcohol (wood spirit). If this substance was added in sufficient quantity, the nitro-glycerine was, in Nobel's opinion, rendered sufficiently insensitive for the mixture to be transported without danger. It was possible to eliminate the wood spirit before use by putting the mixture into water, in which wood spirit readily dissolves, while nitroglycerine will not, so that by this means the consumer could acquire the explosive oil without danger. The addition of wood spirit would also have the advantage of preventing the nitro-glycerine from freezing while being transported or warehoused. The application for a Swedish patent covering this process was sent from New York and dated the 20th May, 1866, the patent being granted on the 1st October of that year.

By that time, however, Nobel had already discovered another and more practical solution of his difficulty, which was to induce the absorption of nitro-glycerine by a solid substance, and thereby make it available for use in a less dangerous and more practical form.

This idea is already adumbrated in his earlier patents of 1863 and 1864, in which the absorption of nitro-glycerine by porous substances such as charcoal is mentioned, or its mixture with powdery or fibrous substances, such as gunpowder, guncotton

or nitrated paper. The main reason why Nobel did not take this course earlier seems to have consisted principally in the apparent advantages offered by unmixed nitro-glycerine, owing to its simpler manufacture, its greater explosive power, and the fact that it could be caused to explode comparatively easily.

After his return to Hamburg at the end of August, 1866, Nobel proceeded to experiment with solid absorbents. His assistant in these experiments was a German retired sapper officer, Carl Dittmar, who had been made manager at Krümmel some months before, to superintend the reconstruction of the factory and the reorganisation of production.

(The former factory manager, Briese, had been sent to America to superintend the construction of factories and production in that country.)

Dittmar, who was dismissed in the autumn of 1867 as being unfitted for the position, tried afterwards to maintain that the idea of dynamite had really originated with him, an assertion which was refuted by Alfred's earlier patents, which have been mentioned, as well as by the correspondence and the statements of witnesses familiar with the facts of the period. He caused Nobel a lot of trouble over a period of years, by infringing his patents and by litigation in the United States.

According to a story of the type common in the history of invention, the discovery of dynamite was due to an accident. As has already been mentioned, kieselguhr (a kind of clay) was used as packing for the cans in which nitro-glycerine was transported, by reason of its lightness, its constant quality, and its great powers of absorption. According to this tale, some nitro-glycerine having trickled out of a faulty can, it formed a paste with the kieselguhr, with the result that dynamite was spontaneously formed. The inaccuracy of this account is proved by Nobel's own verbal and written statements, which are supported by his correspondents and

the statements of witnesses. In point of fact Nobel tried various other absorbents before kieselguhr, including powdered charcoal, wood shavings, cement, brickdust, and it was only after the most exhaustive trial blasting operations with the various mixtures, carried out in the Klausthal, Königshütte, Dortmund and other mines, that he decided in favour of kieselguhr, as having the advantage of a greater absorbent capacity, combined with a stable chemical nature.

He seems to have hesitated for some time between powdered charcoal and kieselguhr, and in the autumn of 1866 he reported to his brother Robert on his experiments with powdered charcoal. Robert wrote him a long letter on this subject, on Christmas Day, 1866, which contains the following passage:

"I am particularly pleased with your method of mixing nitro-glycerine with charcoal. I carried out three blasting operations yesterday in comparatively shallow holes, and found that the effect was much more powerful than with the nitro-glycerine alone; we used water as well as sand for packing the charge—always with equal success. It has recently been noticed on countless occasions that the whole charge did not explode, which may easily have been due to the fact that the charge was too powerful in relation to the resistance of the species of rock. I think we may assume that this happens nearly always, with the result that a portion of the explosive oil is dissipated unexploded. Apart from the fact that your new process avoids this, the force of the explosion is more evenly distributed, owing to the greater area of the mass. I am almost led to believe that you used too little nitro-glycerine in the mixture at Klausthal, or you would be simply delighted with your new discovery. I have made a firm paste of the mixture, rather like thick boot blacking. Much smaller amounts of this mixture can be caused to explode in shallow holes by means of percussion caps than could be exploded if they consisted of pure nitro-glycerine.

One great advantage of this mixture is that the workmen learn to economise with it, also that it does not require cartridges, and that it can be used in the narrowest places and in the deepest shafts without danger. I foresee a great future for it . . ."

Alfred Nobel's final decision in favour of kieselguhr as an absorbent may be largely attributable to the fact that he found that sour nitro-glycerine was liable to ignite spontaneously when brought into contact with certain organic substances such as wood-shavings. Dynamite was manufactured in two qualities: No. 1, containing about 75 per cent nitro-glycerine and 25 per cent kieselguhr, and No. 2, containing 66 per cent of nitro-glycerine.

In October, 1866, extensive experiments were carried out in the presence of a committee of experts at Krümmel, partly with kieselguhr dynamite, and partly with "methylised" nitro-glycerine, with a view to demonstrating the comparative safety of the use of nitro-glycerine in these two forms. It was not until the beginning of 1867 that the firm of Alfred Nobel & Co. began to deliver dynamite in considerable quantities, as well as the "methylised" explosive, to German mines, while Nobel's patents covering the new invention ("dynamite, or Nobel's safety powder") are of a still later date, the English patent being dated the 7th May and the Swedish the 19th September, 1867.

These facts show that Nobel proceeded very cautiously, and endeavoured to gain the necessary experience and thoroughly to work out and perfect his discovery before placing the new commodity on the market in any large quantity. He was no doubt influenced, too, by the terrible experiences resulting from the faulty manufacture of nitro-glycerine during the early years at Krümmel, but he may also have had his doubts as to the respective advantages of nitro-glycerine and dynamite in actual practice.

That nitro-glycerine still had many supporters in the mining industry is revealed by the public records in Sweden, from which

it appears that the managements of a number of mining companies applied for permission to transport nitro-glycerine in small quantities on the public roads, which permission was granted, subject to the proviso that it should be mixed with at least 2 per cent of benzol or nitro-benzol, this being a variation of Nobel's idea, which has been described above.

This special exemption remained in force until the introduction of the new explosive regulations of 1897, and it was not until that year that the use of nitro-glycerine as an explosive, which had been retained in certain mines with an obstinate conservatism, was finally given up.

Elsewhere dynamite came more quickly into general use after exhaustive experiments in various countries had proved that it could be handled with safety, and had revealed its other advantages over nitro-glycerine. Apart from the experiments carried out on various occasions by Nobel in certain countries, experiments were carried out in Königshütte by the mining expert Meitzen, and in Austria by a commission of sapper officers, which included von Trauzl, who wrote some of the first exhaustive treatises dealing with nitro-glycerine and dynamite, and in Switzerland in 1869 by a special government commission.

In a paper read to the Society of Arts in London on the 21st May, 1875, Alfred Nobel gave the total sale of dynamite from 1867 to 1874 as follows:—

1867	. . .	11 tons
1868	. . .	78 ,,
1869	. . .	185 ,,
1870	. . .	424 ,,
1871	. . .	785 ,,
1872	. . .	1,350 ,,
1873	. . .	2,050 ,,
1874	. . .	3,120 ,,

These figures show the continual and rapid increase in the use of dynamite in industry, although the figures are negligible compared with world consumption at the present time. From the purely practical point of view there are few modern discoveries comparable to dynamite with regard to the importance which it has actually acquired. In transport it has proved revolutionary in two ways. A large number of the greater tunnels, submarine blasting operations and canal constructions of the present day could not have been carried out without it. It opened up new possibilities in mining, and came to play the most enormously important part in its economic development. It has become indispensable in all road construction, and in bringing land under tillage.

It is true that the old kieselguhr dynamite has had to give up its pride of place. It has been pushed into the background by Alfred Nobel's later discovery, blasting gelatine, as well as by a mixture of nitro-glycerine and so-called "active dope," of which we shall hear more. In certain countries, but not in Sweden, dynamite—"dynamite No. 1" as it is quite rightly still called—has succeeded in maintaining its position. And it still remains as the first rational and practical solution of the modern problem of explosives.

The suggestion, which constantly recurs in the literature of explosives, that this invention was due to a pure accident, was exceedingly irritating to Alfred Nobel. When Trauzl gave currency to this story, in one of his early essays, Nobel disputed the accuracy of his statement with a certain acerbity, in a letter to him dated the 2nd March, 1881. In his correspondence with Major Majendie, His Majsety's chief inspector of explosives in Great Britain, he gives the following more detailed account of the early history of this discovery, in a letter dated the 7th July, 1883:

"I made and exploded the first Dynamite—without a detonator

but under strong confinement—towards the end of 1863. It consisted of Nitro-glycerine absorbed in porous charcoal, about 2 parts of the former to 1 of the latter. Foreseeing its ultimate importance, I pointed out in some of my patents of 1864 'Nitro-glycerine absorbed in charcoal or other porous substances.'

"At that time, however, I was not aware of the great porosity of Kiselgur, which came under my notice only a few months later. But the choice of the absorbing medium is not of such importance as is generally admitted, and some kinds of charcoal, carbonate of magnesium and wood-pulp are even more porous than 'guhr.'

"I certainly never noticed on any one occasion an accidental leakage of Nitro-glycerine into the Kiselgur packing in such quantity as to form a plastic or even moist material, and the idea of such an occurrence must have been originated formerly by someone who took a guess for a certainty.

"What brought my attention to the use of Guhr for Dynamite was its great bulkiness when dried, which, of course, testified to great porosity.

"It may appear strange at this distance of time that Dynamite, though substantially originated and experimented with on a small scale as early as 1863, should have been brought out for use only in 1866. But please bear in mind that liquid Nitro-glycerine had not yet proved unmanageable, that Dynamite, to become perfect, needed the use of detonators of special kind, and that I had to face the difficulty of displacing a stronger explosive—nitro-glycerine—by a weaker one (dynamite). Hence the temporary necessity to render liquid Nitro-glycerine available for the benefit of those—and they were numerous—that would insist on using nothing but the liquid explosive. This led to my schemes of adding methylic alcohol, and also of washing the Nitro-glycerine out of dynamite. The latter mode, however, was never practically worked at all."

CHAPTER VI

THE FOUNDATION OF A NEW WORLD INDUSTRY

HIGHLY cosmopolitan by education, Alfred Nobel was early persuaded of the world-wide importance of his discoveries. He might with full justice have adopted the proud motto, " The world is my field."

His compendious achievements were, however, realised at the expense of vast toil and worry, and by virtue of a rare combination of inventive genius, energy and directive effort, as well as a gift for finance and economic realities uncommon amongst inventors, of which qualities this short sketch can give only the barest indication.

Even at the time (during the years 1864 and 1865) when Alfred Nobel was taking out patents for his different inventions in various countries, he had begun negotiations for their exploitation and for founding factories in various places.

As we have already seen, his brother Robert began to manufacture nitro-glycerine in Finland in August, 1865. In Norway Wennerström, Nobel's partner in the Swedish Nitro-Glycerine Company, was instructed to sell the nitro-glycerine patent in that country. These negotiations were successful, and the first factory was built near Lysaker in the summer of 1865. This factory was shortly afterwards destroyed by an explosion, after which the manufacture was transferred to Engene near Dröbak on the Christiana Fjord. The Norwegian patent was sold for 200,000

kronen cash.* In March, 1865, Alfred Nobel finally left Sweden and settled in Hamburg, as has already been stated, where he succeeded in starting a factory at Krümmel. He lived there for the next few years except when he was travelling. In the autumn of 1865 he went to Italy, but had no success in that country, and writing home from Turin he said that a London firm had undertaken to sell the English patent for 10 per cent commission, but that he had no confidence in the scheme. In November he went to England himself in order to settle the business, but his efforts proved unsuccessful, and as we shall see, it was not until after six years of negotiation that an English Company was founded.

In the case of France and Austria, Immanuel Nobel had asked a friend of the family, the well-known railway engineer, Count von Rosen, to undertake the negotiations. But Alfred seems at the beginning of 1865 himself to have applied to Austrian financiers, for in April of that year his mother wrote to him: "What is happening with Austria, is there anything doing there?" Meanwhile Nobel, Winkler, and Dr. Bandmann, were carrying on the negotiations from Hamburg, and were delivering samples to Bohemian mines. In 1868 Alfred Nobel & Co. of Hamburg set up a dynamite factory at Zamky near Prague. The Austrian sapper officer Trauzl played a conspicuous part in the introduction into Austria of the new explosive dynamite; he himself became famous as an inventor in this field, and as a pioneer in the working out of methods for investigating explosives.

Alfred Nobel directed his attention quite early to the United States of America, as offering the prospect of providing an important market for his explosives. His partner in Hamburg, Dr. Bandmann, brought him into touch with a "Colonel" Bürsten-

* As far as is known this is the only instance in which Alfred Nobel sold a patent out and out for cash; it was probably owing to the fact that both he and his parents were in urgent need of money at the time. Otherwise he always made some kind of a share in the exploitation of his inventions a condition of the sale.

binder of New York, who took steps to form a company for the exploitation of Nobel's inventions in America.

The patent for the use of nitro-glycerine was granted to Alfred Nobel in the United States on the 24th December, 1865, and in January, 1866, Bürstenbinder, without being actually authorised to do so, made a provisional agreement for the sale of the patent for the United States to a company that was to be incorporated with a share capital of 1,000,000 dollars. Nobel was to receive for his invention a share in the company to the value of 250,000 dollars, and in addition 20,000 dollars in cash, of which 10,000 dollars were to be payable on the transfer of the patent, and the balance as soon as a factory had been built and was working to the extent of a daily production of a thousand pounds.

From the very start difficulties presented themselves in connection with this agreement. Nobel had to deal both with a number of astute and highly unprincipled industrial adventurers who were simply out to get hold of his invention, and also with rival inventors who exploited his ideas and came into the field with variations of their own. He had already had to do with a typical representative of the former category, a certain Colonel Shaffner in Stockholm, where Shaffner was staying in the autumn of 1864 to carry out some official investigations. Shaffner had visited Immanuel Nobel at Heleneborg in September, 1864, and had expressed his admiration of the discovery of the use of nitro-glycerine for explosive purposes, and had also said that he would like to buy it. Count von Rosen had acted as interpreter during the conversation. Shaffner met Alfred Nobel himself on various subsequent occasions, and was always trying to cross-examine him on the discovery of nitro-glycerine and the method of its use. He had offered an inconsiderable sum, 10,000 Spanish dollars, for the American rights, and when Nobel refused this offer, Shaffner had written to the American Minister in Stockholm asking him to obtain

information as to the method by which the oil was caused to explode. The Minister had sent him a curt refusal. These facts are all contained in an affidavit made by Count von Rosen, who was highly indignant at Shaffner's conduct.

Meanwhile Nobel's invention was patented in America on the 25th October, 1865. Shaffner, who had himself applied for a patent for the use of nitro-glycerine, had the hardihood to bring an action against Nobel on the ground that the invention was his. Depositions of witnesses were accordingly taken down before the American Consuls at Hamburg and Stockholm in the presence of Nobel and Shaffner. The Ammeberg workmen, who had assisted at Nobel's explosive experiments in the autumn of 1863, as well as Captain Wennerström, testified to Nobel's priority as inventor, and the action was accordingly decided in his favour.

In order to settle his business affairs Nobel went to New York himself in April, 1866, and remained there until the end of July. He arrived back at Hamburg on the 11th August of that year. In order to be relieved of the worry caused by Shaffner's intrigues, Nobel transferred to him on the 16th May, 1866, for the nominal consideration of one dollar, the exclusive right to exploit the nitro-glycerine patent in the United States *for military purposes.* He also surrendered his patent rights to the recently formed "United States Blasting Co." on the terms described above, at the same time undertaking to hand over to that Company without charge any future improvement or new discoveries affecting nitro-glycerine.

The new company, many of whose beautifully designed share certificates are still preserved in the archives of the Nobel Foundation, proved to be from the start a pure swindle, at any rate by European standards. Only a small proportion, about 5 per cent of the authorised share capital of 1,000,000 dollars, was actually subscribed in cash, and that mainly by one of the founders of the

Company, a certain Israel Hall. The rest of the shares were to be issued when the company had started business. The building of the factory was delayed through the action of Bürstenbinder, who had received a consignment of various apparatus from Hamburg for the factory, but refused to deliver them until he had been assured certain advantages. When the factory had been completed and Nobel had received his 20,000 dollars, the financial resources of the company were nearly exhausted, and from that time onwards it was in constant difficulties. These difficulties were increased by intrigues, and by a large variety of obstacles which Bürstenbinder and Shaffner put in its way.

After the accidents at Aspinwall and San Francisco, Congress passed a law prohibiting the transport of nitro-glycerine. Through his connections with members of Congress Shaffner succeeded in getting an exemption for nitro-glycerine, packed in a certain manner which he had patented—the nitro-glycerine was to be packed in double cans, the inner can having a coating of plaster, and with water between the two! He now asked that Nobel should repay or hand over to him the money he had received from the Company for his patent, and should pay damages in addition!

Meanwhile the sale of nitro-glycerine had increased in California, where the firm of Bandmann, Nielsen & Co. controlled the sales as the agent of Alfred Nobel & Co. of Hamburg, who delivered the explosive oil. It seems to have been due in no small measure to a particularly energetic and fearless Swede, C. S. Swenson, that the interest in the new explosive was maintained. He was probably an ex-seaman, and was employed as an agent by B. N. & Co.*

As Bandmann, Nielsen & Co. wished to found a company in California for the manufacture of nitro-glycerine, Nobel advised them to negotiate with the U.S. Blasting Oil Co., which owned the

* His report on the journey to Sacramento and the interior of California of November, 1866, with eleven cases of nitroglycerine is full of details that have a certain grisly humour. This report is quoted in Appendix No. IX.

patent, with a view to co-operating and dividing up the field of operations. These negotiations were begun, but the New York company conducted them in a procrastinating and unreasonable manner. Meanwhile Nobel discovered dynamite, and Bandmann, Nielsen & Co., as well as their friends, therefore increasingly lost interest in the older nitro-glycerine patent. In order to obtain a decision, Nobel's partner, T. Winkler, went to San Francisco in June, 1867, where he started negotiations for arranging for the manufacture of dynamite.*

Under Nobel's agreement with the Blasting Oil Company it was at least highly doubtful whether he was under any obligation to hand over his discovery of dynamite to that Company without special consideration. As Nobel had every ground for being exceedingly dissatisfied with the management of that Company, and as he wished to compel an agreement between the two groups interested, in the East and in California, he at first refused to assent to the request of either to have dynamite patented before some such agreement providing for co-operation and the division of the patent rights had been concluded.

As these negotiations seemed to be about to bear practical fruit, he authorised Julius Bandmann to apply for the patent on his, Nobel's, account. When the dynamite patent was granted, J. Bandmann transferred the rights in it to a company formed in San Francisco, the Giant Powder Company, after he had secured the agreement of his brother in Hamburg, but without consulting Nobel, who was in Paris at the time.

That company had about the same time acquired the rights for the Pacific Coast in Nobel's nitro-glycerine patent, but without coming to any agreement regarding future inventions, a condition which Nobel had regarded as essential to the conclusion of the agreement.

* He died, however, in September of that year after arriving at a provisional agreement, but before entering into negotiations with reference to it with Nobel.

This improper manner of proceeding led to further bitter arguments, partly between Nobel and the Company and partly between the companies themselves, as well as between Nobel and Shaffner, who had succeeded in making himself Managing Director of the Blasting Oil Company, and who was now concentrating all his efforts on assuming to himself that company's rights. He actually tried to maintain that dynamite was his invention, and threatened Nobel with further Patent actions.

The final outcome of all these disputes was that the various groups of interested parties agreed to found a new company, to be called the Atlantic Giant Powder Company, which Company contracted, by agreement dated the 12th April, 1873, to take over all the rights of the U.S. Blasting Oil Company, the latter company being a shareholder in it. In order to make such a solution possible Nobel was compelled to a large degree to sacrifice his own rights and interests.

The Giant Powder Company had already built its own nitroglycerine and dynamite factory near San Francisco in 1870. The Swedish engineer, Carl Amark, was responsible for the construction of the factory and the starting of operations; in April, 1870, he took up his duties as factory manager, and spent his first year instructing both the workmen and the technical experts.

An explosion having occurred in 1870 in the factory at Krümmel through which the engineer Rathsman, who was factory manager there at the time, a Swede and friend of Amark's, lost his life, Alfred Nobel wrote certain letters of warning and advice for the new factory.

The two new dynamite companies, manufacturing for the markets on either side of the Rocky Mountains, developed with considerable success from the start, but they also had various kinds of competition to deal with. They were frequently forced to bring actions against persons for infringing their patents. Several of

the rival undertakings having grown so powerful that it seemed doubtful whether they could be fought successfully, an agreement was arrived at between the various companies, providing for co-operation and division of profits. The share capital of the Atlantic Giant Powder Company was increased to 3,000,000 dollars, of which one-third was allotted to the other companies that were absorbed, and the rest pro rata to the old shareholders of the Atlantic Giant Powder Company.

Alfred Nobel continued to be a shareholder in the two Giant Powder Companies until 1885, when he sold his last holding. There is no doubt that his American business caused Nobel a great deal of worry and difficulty, and that he got a comparatively small return for the value of his discoveries. An exhaustive perusal of the mass of documents dealing with these curiously complicated negotiations clearly reveals that Nobel himself constantly endeavoured, while protecting his own interests, to act as an honourable man should, but that he had to deal, in many cases, with a particularly unscrupulous set of business men. The documents still available reveal Shaffner particularly as having been a man possessed of certain gifts undoubtedly, but hampered by no moral scruples of any kind.

It was in England that Nobel generally first endeavoured to secure the protection of patents for his inventions, and he did so more extensively in that country than in any other. The patents granted to him there in 1863 and 1864 for the use of nitro-glycerine as an explosive, and the dynamite patent of the 7th May, 1867, are essentially similar to the Swedish patents which have already been described. On the 12th February, 1869, he was also granted a patent for dynamite in England, which provided that the absorbent should be a mixture of saltpetre and carbons or hydrocarbons.

It was, however, some considerable time before nitro-glycerine explosives became sufficiently recognised in England to make it

possible to start manufacturing in that country. As has already been mentioned, nitro-glycerine was first imported into England from the Krümmel factory. On the 13th February, 1866, while Alfred Nobel was on a visit to England in order to introduce the new explosive, T. Winkler wrote to him to say that in accordance with his instructions a consignment of twelve cases containing 25 pounds each was being despatched to London, and on the 26th February of that year, a further consignment of " oil, percussion caps, and cartridge cases " (presumably soft cases for use in bore holes, for putting in a charge of nitro-glycerine explosive) was despatched. Nobel visited London again in April of that year, on his way to America, and tried to arrange for the establishment of a nitro-glycerine dump near London.

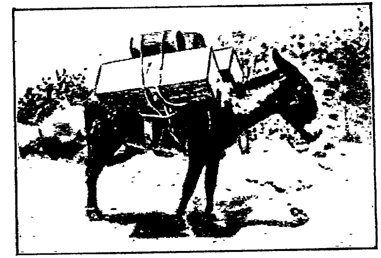
It appears that in the beginning nitro-glycerine found its most important market in the stone quarries of North Wales, where two quarries alone consumed nine tons of explosive between the years 1866 and 1868, although, owing to the cost of transport, its price was very high, being 3s. 3d. a pound, as compared with 4½d. for ordinary blasting powder.

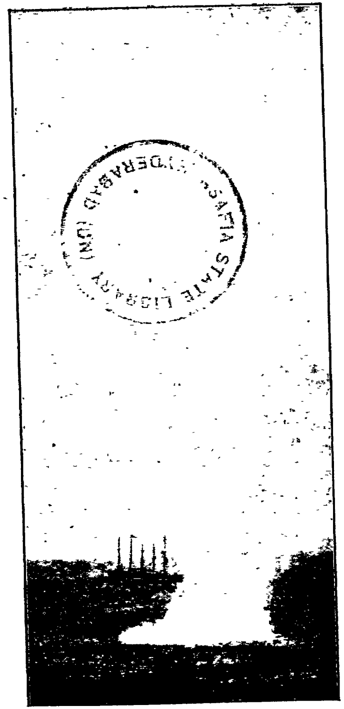
The disasters of 1866 caused by the spontaneous combustion of nitro-glycerine had produced grave misgivings in England, and it required years of patient endeavour on Nobel's part, and demonstrations and lectures on the newly-discovered dynamite, to enlighten public opinion as to its nature. On the 14th July, 1867, he personally carried out a series of experiments in the quarry at Merstham, near Redhill, in Surrey. A large gathering of eminent persons was present, including leaders in the mining industry, quarrying, in road construction and in water works. It appears from the reports of contemporary English technical periodicals that Nobel first demonstrated that charges of dynamite could be ignited and burned without exploding. Then a case containing ten pounds of dynamite was placed on a pile of wood and burnt,

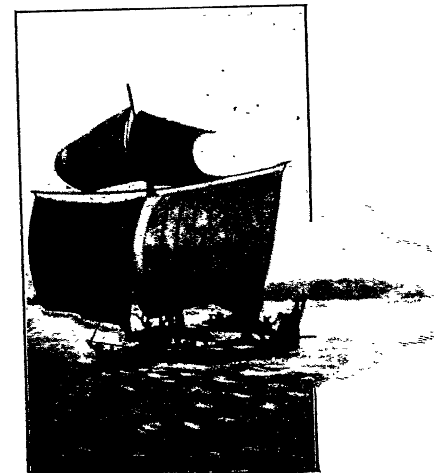
and a case containing a similar amount of dynamite was thrown from a rock sixty feet high. In neither case did any explosion occur. The action of dynamite when fired with a fuse and detonator was demonstrated upon an oak beam, a large stone, and a wrought iron cylinder, with charges of different strengths. Finally a borehole fifteen feet deep in the quarry was filled with a charge of 13½ pounds of dynamite, which was then detonated. All the experiments were perfectly successful, and the spectators were exceedingly impressed. In 1868 Nobel read a long paper at the annual meeting of the British Association at Norwich, explaining the technical and economic advantages of nitro-glycerine and dynamite, as compared with gunpowder. He pointed out that the accidents with these explosives were attributable to ignorance or carelessness, and mentioned particularly the experience of Sweden, which country had been a pioneer in the introduction of the new discovery in the field of explosives. He also represented these views in the press, as for instance in an article which he contributed to *The Times*, dated Hamburg, the 24th December, 1867; in that article he related a series of incidents that had come to his knowledge, showing incredible carelessness in the handling of nitro-glycerine, which by a wonderful chance had not resulted in any accident, but which might serve as an indication of the manner in which accidents had actually occurred.

The English authorities, however, continued to regard nitro-glycerine and explosives containing nitro-glycerine, such as dynamite, with the greatest suspicion.

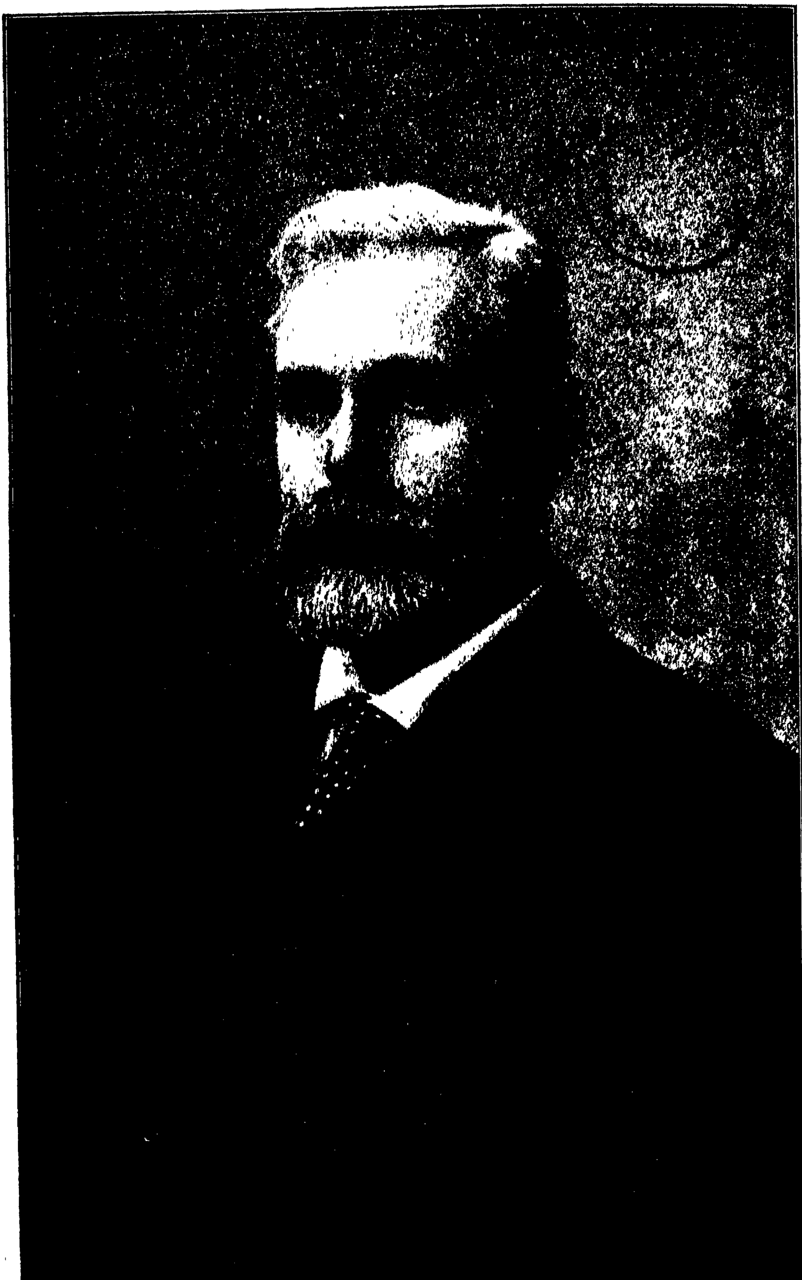
An Act of Parliament of the 11th August, 1869, prohibited the manufacture, import, sale and transport of nitro-glycerine within Great Britain. This prohibition was extended to compounds containing nitro-glycerine, although the Home Secretary was empowered, in individual cases, to authorise the import of such nitro-glycerine compounds as were proved to be comparatively







METHODS OF TRANSPORTING DYNAMITE



safe. Nobel's agents, however, Messrs. Webb & Co. of London, and J. Downie of Glasgow, bitterly complained of the great difficulty they experienced in obtaining such permits, and for this reason Nobel wrote three masterly letters in 1869 and 1870 to the then Home Secretary, Mr. Henry A. Bruce, asking that these difficulties should be mitigated. He referred to the experience of other countries such as Germany, Austria and Sweden, and to the reports of several official commissions which had pointed out that dynamite could be stored and transported in comparative safety. He protested especially against dynamite being treated unfairly, as he maintained, in comparison with guncotton, which had been the cause of much more numerous and more serious accidents than dynamite, while its practical use was much more restricted and quite insignificant compared to that of dynamite.

Professor Frederick Abel was the Government and Parliamentary expert for the administration of the Nitro-glycerine Acts of 1869; he is famous in the history of the science of explosives particularly because he succeeded in achieving the chemical stabilisation of gun-cotton. Abel had successfully advanced serious objections to dynamite, which he actually regarded as being more dangerous than nitro-glycerine. Nobel, perhaps not entirely without reason, attributed Abel's opinion, which seems to have had a great influence with the Government and with Parliament, to his prejudice in favour of gun-cotton, to which Abel had devoted the most careful study. Nobel pointed out in his letter of the 29th March, 1870, that up to that date about 560 tons of dynamite had been manufactured, transported and stored, without a single accident having taken place in transit or otherwise. His letter further stated: "560 tons of Dynamite are equal in blasting power to 2,800 tons of gun-powder. By glancing over the school-days of mankind in the use of the latter substance we may easily find that it behaved less gently than Dynamite has done under equal want of experience.

"The distinguished advocate for gun-cotton in England and chief adviser of the House of Commons on Dynamite matters, therefore appears to have exaggerated the danger of the latter substance. Or, if it is so highly dangerous as he reports it to be, it is certainly a wonderful 'run of luck' to have had no accident on such large quantities. And if gun-cotton is as safe as he mentions, why is it that a comparatively trifling consumption of that material has given rise (in Austria and elsewhere) to numerous and serious accidents."

After explaining the cause of most accidents in the use of dynamite Nobel's letter continued: "It cannot be expected that an explosive substance should come into general use without waste of life. A simple reference to statistics will show, that the use of fire-arms for play is productive of incomparably more accidents than this substance, which is a great and valuable agent, for the development of our mineral wealth."

Nobel concluded by pointing out how exaggerated were popular notions regarding the effects of dynamite explosions at a distance, even where large quantities were concerned, and that ordinary gunpowder, having a greater power of scattering fragments, as for instance when blowing up buildings, was really much more dangerous in this respect.

His representations do not seem to have been without effect, for permits for the use of dynamite were granted much more readily afterwards.*

At this time Nobel was negotiating with various parties for the sale of his English Patents and the erection of a dynamite factory in the British Isles. Having succeeded in interesting a number of Scottish financiers in the matter, he came to an agreement with John Downie at Glasgow in 1871 for the sale of his patents to a new company with its headquarters at Glasgow, which was called the

* See also Appendix X.

"British Dynamite Company." The share capital of the company was to be £24,000, divided into 2,400 shares of £10 each. 1,500 shares were to be paid for in cash, 900 shares being issued to Alfred Nobel in consideration for his Patents. Nobel also undertook to subscribe and pay for 300 of the 1,500 shares, whereby he controlled one-half the share capital of the Company. Moreover, he undertook without any payment, apart from the special expenses involved, to deliver complete drawings and plans for the factory, and to give his advice and instructions for the works, and also to place his services at the disposal of the company as scientific director, and to allow it to have the advantage of any future improvements in his patents. The members of the original Board were, besides Nobel, John Moffat of Ardrossan, A. Galbraith, Charles Randolph and H. A. Rennie, all of Glasgow. John Downie was appointed General Manager. The Company immediately proceeded to build a dynamite factory at Ardeer, near Ardrossan, on the West Coast of Scotland, a spot which Nobel had himself selected, and which offered exceptional opportunities for future developments.

The actual direction of the construction of the factory and of the early stages of manufacture was entrusted to a friend and loyal colleague of Nobel, the Swedish engineer Alarik Liedbeck, who had hitherto been factory manager at Vintervicken. The building of the factory took about two years. On the 13th January, 1873, nitro-glycerine was first produced in this factory, which afterwards became one of the greatest nitro-glycerine factories in the world. McRoberts, a Scotsman, was appointed factory manager, and some years later a Swede, C. O. Lundholm, was appointed chief engineer. Towards the end of the 'eighties Lundholm became the technical manager, a position which he occupied for about twenty years, remaining as technical adviser to the Nobel Dynamite Trust Company for a further period of ten years.

In 1875, Nobel having made another important discovery,

namely that of blasting gelatine, it appeared advisable to enter into a new agreement for the purpose of taking over the British patent. In this connection it was decided to purchase a fulminate of mercury and detonator factory which Nobel and McRoberts had built in the western part of Scotland. For this purpose a new company was formed under the name of Nobel's Explosives Company, having a share capital of £240,000 divided into shares of £10 each. These shares were to be issued in payment for all the assets of the older company, being divided amongst the shareholders in that company, subject to their option if they so wished to receive the face value of the shares in cash. In the course of four years therefore the value of the shares in the British Dynamite Company had increased ten-fold, an eloquent proof of the value of Nobel's discovery. While handing over his patents to Nobel's Explosive Company Nobel secured to that Company the rights in any further discoveries he might make in the field of explosives, with the exception of such as related to " propellants." He was to receive 5 per cent on the selling price of all blasting gelatine sold during the period of the patent.

The career of Nobel's Explosives Company was no less successful than that of its predecessor. A patent action brought against the German firm Krebs & Co. was decided in Nobel's favour, and his company completely controlled the English market for a long period of years. Krebs & Co. had been importing into England a kind of imitation of dynamite which they called " litofracteur " ; it contained nitro-glycerine which had been absorbed by a mixture of Kieselguhr, powdered charcoal or sawdust, saltpetre and sulphur. Krebs & Co. had also begun the construction of a factory for the manufacture of this explosive.

In the course of time the Nobel Company developed a considerable export trade to countries outside Europe, especially to South Africa, Australia, Asia and South America. Subsidiary companies

were formed in several places, and the company itself acquired shares in a number of undertakings, including the following:

British South African Explosives Company (now African Explosives & Industries Ltd.) founded to meet the explosive requirements of South Africa, and especially the Transvaal.

Hamilton Powder Company (later Canadian Explosives, Ltd.) and Northern Giant Powder Company of Canada (all of which are now emerged in Canadian Industries, Ltd.).

Japanese Explosives Co., Ltd. (since taken over by the Japanese Government in Japan).

Societé Anonyme d'Arendonck in Belgium, and several others.

In 1886, after long negotiations, in which Alfred Nobel, with the support of his partner Barbe, took a leading part, regarding which we shall have more to say later, the Nobel Dynamite Trust Company was formed. It had a share capital of £2,000,000, and its object was to take over all the shares in Nobel's Explosives Company as well as a controlling interest in a number of German and other explosives factories. The companies thus merged included:

Nobel's Explosives Company, Glasgow;

Dynamit Aktien-Gesellschaft, formerly Alfred Nobel & Company, Hamburg;

Rheinische Dynamit-Fabrik, Opladen;

Deutsche Sprengstoff-Fabrik, Hamburg;

Dresdner Dynamit-Fabrik, Dresden; and the subsidiary companies controlled by these various larger organisations.

In return for the shares in Nobel's Explosives Company, which had paid dividends over a period of years, averaging between 12½ per cent and 20 per cent, the shareholders in that company were allotted for each £10 share a £25 share in the Nobel Dynamite Trust Company.

In consequence of the World War the Nobel Dynamite Trust Company was wound up in 1915, its assets being divided amongst

the shareholders in the various countries. The British shareholders received for their holding, shares in the Nobel's Explosives Company, and that company retained the bulk of the shares in the subsidiary companies within the British Empire.

In November, 1918, the whole British explosives industry was unified in a single organisation of which Nobel's Explosives Company was the nucleus, the various competing undertakings being united with that company into a new enormous trust which was called Explosives Trades Ltd. After a few years however it was found that the name Nobel was a title of nobility in the world of industry, and constituted an historical asset which could not be lightly dispensed with; the name of the trust was accordingly changed to Nobel Industries Ltd. The share capital of this company amounted to £16,000,000 sterling, and its total assets were valued at about £24,000,000.

Finally in the years 1926 and 1927 a still greater fusion was effected whereby Nobel Industries Ltd. was merged with three other important concerns controlling England's chemical industry, the new company being called Imperial Chemical Industries Ltd. The share capital of this great trust amounts to £95,000,000, and its predominant position in the chemical industry of Great Britain is comparable with that of the I.G. Farbenindustrie in Germany.

Alfred Nobel had become acquainted with France in his youth, as he had with England, and he was attached to that country also by special ties of affection. He therefore endeavoured early to introduce his discoveries affecting nitro-glycerine as an explosive into France.

The French State Monopoly for the production and sale of powder, which it was held should cover nitro-glycerine and dynamite as well, put considerable obstacles in his way from the start: but in the summer of 1865 Alfred appears, according to a letter to his mother, to have succeeded, while staying in Paris, in interesting

the French Government in nitro-glycerine, since a commission was appointed to investigate its use for military purposes. The documents available give no information regarding the conclusions arrived at by the commission. Count N. von Rosen's intended journey to Paris in 1866, with a view to exploiting the discovery of nitro-glycerine in France, had been given up on account of the disasters which had occurred in the use of nitro-glycerine during that year. In January, 1868, Robert Nobel was staying for some time in Paris, in order to introduce dynamite also for military purposes, but he was unsuccessful.

About this time Alfred Nobel got into touch with the firm *Barbe, père et fils & co., maîtres de forges*, at Liverdun, near Nancy, and he succeeded in interesting the partners, and especially the son, M. Paul Barbe, in his discovery of dynamite. In May, 1868, a provisional agreement was concluded, which provided for a partnership for the exploitation in France of Nobel's discoveries. The Barbes were to provide the necessary capital, estimated at 200,000 francs, and to have the right, after drawing 6 per cent interest on this capital, a prior charge, to half the profits. This partnership remained in force until Paul Barbe's death in 1890, and was gradually extended to cover an ever wider field.

Nobel often makes mention of Barbe in his letters; his rare and many-sided gifts, his commercial genius and his unique talent for organisation had made a deep impression upon him. At the same time he had noticed in Barbe a certain unscrupulousness that gave him qualms. He made the following remark about him in a letter to his brother Ludwig: "He is an excellent fellow and exceedingly industrious, but his conscience is as flexible as indiarubber. This is a pity, for it is rarely that one finds a person combining so many intelligent qualities." In 1883, when the question arose of appointing a chief of the great works at Baku, he wrote to Robert Nobel:

"It is not easy to find someone who would be competent to

control this enormous concern effectively and firmly. I know only one such man, Barbe. He has a marvellous scientific imagination, is an exceptionally good salesman, a far-seeing business man, and knows how to make the best of people, and to get out of each man the individual work of which he is capable. His own achievements are as incredible as his power to work; but he is unreliable unless his personal interest is involved. This is a hateful defect, but I know of none whom I would so gladly see joint manager with Ludwig in that concern, for it would in a short time expand enormously without any financial difficulties. '*C'est un géant,*' one of the most successful Paris bankers said of him recently; and that is true."

In December, 1869, Paul Barbe went to the French Finance Ministry which dealt with the monopoly, and asked for permission to import a ton of dynamite from abroad for experimental purposes; in May, 1870, he approached the Ministry with a view to building a dynamite factory in the country. Both requests were referred to various departments; but the monopoly factories brought the strongest pressure to bear against these applications being approved. Meanwhile the Franco-German War broke out. The Germans made use of dynamite, and the French military command decided that it was essential that they should also have a supply of this new powerful explosive. Marshal le Boeuf, the War Minister, accordingly summoned Paul Barbe to Paris, with a view to making arrangements for the manufacture of dynamite there. Barbe had been an artillery officer and had joined the army; he had been engaged at the defence of Toul, and had been taken prisoner when that town capitulated. It was not therefore until after the termination of the war that he received the War Minister's command. Having received permission to return to Nancy, he succeeded somehow in reaching Tours, where the new Republican Government was installed. The question of the manufacture of dynamite in

France was reopened, and on the 31st October, 1870, Gambetta, as War Minister, signed on behalf of the French Government, an agreement for the building of a dynamite factory, to be assisted by the State with a loan.

No time was lost. At top speed a factory was built at Paulilles, in the south of France, and production was started as early as March, 1871. On the 14th March, 1871, the first consignment of dynamite left Paulilles, and within a very short time, considerable quantities were being delivered to the French army. In Paris rather more primitive arrangements for the manufacture of nitro-glycerine and dynamite were successfully carried out, under the direction of the engineer Brüll, collaborator of Barbe.

After the conclusion of the armistice Barbe worked energetically and with a certain success at introducing dynamite as an explosive in such undertakings as railways, mines and quarries. The communist outrages seem to have produced somewhat exaggerated alarm in France, for, as the result of the resolution of the National Assembly dated the 19th June, 1871, which prohibited all manufacture of explosives, Barbe was notified that the factory at Paulilles must cease work. In vain he protested on behalf of his two partners against this breach of contract by the French Government, demanding compensation. Compensation was refused, and it was not until after years of negotiations that the manufacture and sale again became possible in France. This was in the year 1875, when manufacture was resumed at Paulilles.

Meanwhile production was carried on under what were obviously rough and ready methods at Liverdun in order to deliver dynamite to Belgium, and presumably to that part of France which was occupied by the Germans. Moreover negotiations were in progress for the manufacture in Switzerland and Italy. In Switzerland Nobel and Barbe built a factory at Isleten near Fluelen, and in Spain they built a factory at Galdacano near

Bilbao. By October, 1872, production was in full swing there. Dynamite was exported to Italy first from Paulilles, from Isleten, and from Zamky near Prague, where Alfred Nobel & Co. of Hamburg had built a dynamite factory. Italy, however, soon also felt the need of having a dynamite factory within her territory, and in 1873 a factory was accordingly built at Avigliana near Turin.

It may be convenient to the reader here to quote a list which Nobel detailed in the lecture to the Society of Arts already referred to. This list enumerates the dynamite factories founded by Nobel, or with his collaboration, which then numbered fifteen, as follows:

	Founded
Vinterviken in Stockholm	1865
Krümmel in Hamburg	1865
Lysaker (later Engene), Norway	1866
Zamky in Prague, Bohemia	1868
California Powder (Giant Powder Co.) in San Francisco, California	1868
Hango, in Hango, Finland (in place of the former factory at Helsingfors)	1870
Ardeer, in Glasgow, Scotland	1871
Paulilles, at Port Vendres, France	1871
Schlebusch, near Cologne	1872
Galdacano, in Bilbao, Spain	1872
Giant Powder Works, in New York, U.S.A.	1873
Isleten in Fluelen, Switzerland	1873
Avigliana, near Turin, Italy	1873
Trafaria, near Lisbon, Portugal	1873
Pressburg, near Pressburg, Hungary	1873

Very soon a certain rivalry developed between the various Nobel dynamite factories with regard to deliveries to the so-called

free markets, that is, especially to countries outside Europe where there was no native manufacture. Moreover, within their own countries the factories had to deal with fairly severe competition with outside explosive concerns which, attracted by the profitable business done by the Nobel factories, had proceeded to manufacture new or modified explosives. During the 'seventies and the early 'eighties Nobel and Barbe were constantly occupied with questions of organisation, the main problem being to secure co-operation between the various concerns and to harmonise conflicting interests.

Separate companies came to be formed in various countries to take over the factories which the original companies of Alfred Nobel & Co. and Nobel-Barbe had built and started running. Thus Nobel and Barbe handed over their patent rights in France, as well as the factory at Paulilles, to the *Société Générale pour la Fabrication de la Dynamite* which had an original share capital of three million francs. The Swiss and Italian factories were taken over by the *Société Anonyme Dynamite Nobel* which was formed in 1872 with its headquarters at Isleten. For Spanish manufacture the *Société Espagnole pour la Fabrication de la Dynamite* was formed and the Hamburg firm Alfred Nobel & Co. was also turned into a limited liability company under the name of the *Deutsch-Osterreich-Ungarische-Dynamit R.G.*, which was later converted into the *Dynamit-Aktien-Gesellschaft,* formerly Alfred Nobel & Co., in which Nobel and Barbe acquired the controlling interest, Nobel's Hamburg partners, Dr. Bandmann and Carstens, becoming shareholders in the French Company.

In May, 1875, Nobel and Barbe decided jointly to set up in Paris a scientific advisory board for the dynamite factories of the various countries. Alaric Liedbeck, the brilliant Swedish engineer and research worker in explosives, of whom mention has already been made, was selected to preside over this board. During the following years the factories in France, Spain, Italy, Portugal and Switzer-

land, and also, to a certain extent, the entirely independent Swedish and Norwegian concerns, had recourse to this advisory board.

As Nobel and Barbe had much reason to complain of the business management of the German-Austrian Company, they decided, in 1878, to make a change in its management. Barbe accordingly made Hamburg his centre of operations in September, 1878, in order to settle these business difficulties, and remained there until 1881. During these and the following years active endeavours were made to secure co-operation between the competing German factories, and especially with Opladen ; while various schemes for a combination of interests on the one hand, as between the Anglo-German Dynamite Companies, and on the other hand, those in Latin countries, were considered.

The final result of all these efforts was the foundation of two large trust companies, the Nobel Dynamite Trust Company in London, in which was merged Nobel's Explosives Company in Glasgow, and the German Companies mentioned above, and the *Société Centrale de Dynamite* in Paris, which acquired the controlling interest in the French, Spanish, Swiss-Italian and in certain South American and other concerns.

At the start, Alfred Nobel joined the various companies as a member of the board, and in some cases as Honorary President ; but he concerned himself little with the ordinary course of business, intervening in the Administration principally when the introduction of one of his new discoveries was involved, or sometimes in order to effect important administrative changes, or to harmonise the conflicting interests of individual groups. Certain occurrences in the years 1890 and 1891 resulted in his resigning completely his membership of the board.

Barbe died in 1890 ; he had been Minister of Agriculture for some years, and had then taken a keen interest in the Panama Canal scheme. After his death it appeared that he had been rather

seriously implicated in those transactions which came to be known as the Panama Scandal; moreover certain of Barbe's close associates who occupied important positions in the French Dynamite Company, had involved that company in extensive speculation in glycerine, which ended in a crash. Alfred Nobel, who received the first news of this disaster during a visit to Hamburg, thought for the moment that he was a completely ruined man, owing to his possible joint responsibility in these transactions, and he actually considered whether he should apply for the position of chemist in the German company. Fortunately the losses arising out of these speculations proved to be less serious than had at first been feared, and it was possible to meet them by an issue of debentures which the company guaranteed, and a part of which Nobel subscribed for himself. At Nobel's suggestion certain changes were made in the board, M. Paul du Buit, a brilliant and respected man of business, being appointed managing director of the two French companies. Alfred Nobel, however, had had his fill of business unpleasantness, and desired to be able to devote his undivided energies to the development of his inventive gifts. He therefore resigned all his positions on the boards of the dynamite companies. Nevertheless he continued to exercise a determining influence upon them up to his death, partly by reason of his position as an important shareholder, but still more by virtue of his personality and the regard in which he was everywhere held, as well as on account of the hopes which everyone continued to entertain regarding his inventive gifts.

CHAPTER VII

BLASTING GELATINE, BALLISTITE AND PROGRESSIVE SMOKELESS POWDER

WHEN Nobel made Paris his headquarters, in 1873, he set up an experimental laboratory there and engaged M. Georg Fehrenbach, a young French chemist, as his assistant. The latter remained with him for eighteen years, that is, until 1890, when Nobel was compelled to cease his work in France, and to transfer his experiments to San Remo. The laboratory was at first installed in part of Nobel's house, No. 59 Avenue Malakoff, but in 1881 it was transferred to a property which Nobel had acquired at Sevran-Livry near Paris. During the 'seventies and 'eighties Nobel systematically carried on his experiments in various technical fields, devoting particular attention to improvements in the manufacture of explosives, and to the production of new types of explosives.

As has already been emphasised, kieselguhr dynamite marked a technical advance of unparalleled importance as soon as it first made its appearance. But it suffered from certain imperfections and defects in practical use. One of these was that the power of the explosive as compared with pure nitro-glycerine was lessened by admixture with the kieselguhr absorbent, for the latter was not only an inactive element in the explosion, it also absorbed some of the heat generated, thereby lessening the pressure of the gases and the general explosive effect. A further disadvantage consisted in the fact that in certain circumstances there was a risk of the nitro-

glycerine exuding, as for instance, when a charge of dynamite was subjected to pressure or exposed to damp.

Several inventors endeavoured to mitigate the former disadvantage in various ways, as by substituting for the kieselguhr absorbent a mixture consisting partly of hydrocarbons and partly of acid-forming substances, in such proportions that on the detonation complete combustion should take place. This type of explosive was known in England and America as "active dope" dynamite. In his first patent, Nobel was working on these lines too, the absorbent being black powder.* In 1866, as has already been mentioned, he patented a mixture of hydrocarbons and saltpetre in England. Another important discovery in this field was made by the Swedes, Ohlsson and Norrbin, who, on the 31st May, 1867, were granted a Swedish patent for an explosive consisting of ammonium nitrate and sawdust, powdered charcoal or some similar substance, together with an organic nitrate compound; picric acid and nitro-glycerine were specifically mentioned as examples of the latter. Alfred Nobel acquired the rights in this discovery, which may be regarded as the cardinal principle of a whole group of the modern so-called safety explosives, in a number of other countries besides Sweden.

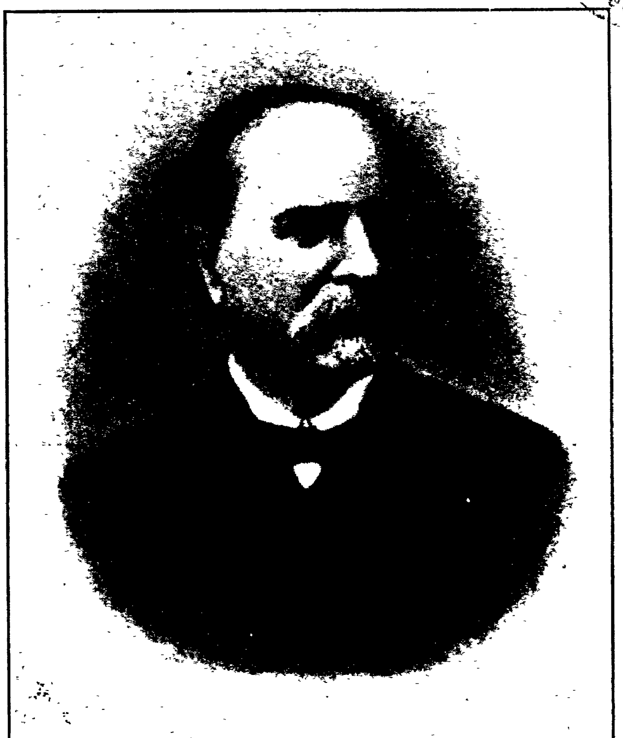
These attempts to solve the problem of producing a completely satisfactory nitro-glycerine of great power did not entirely answer the purpose either. This is partly proved by the circumstance referred to above, that liquid explosive oil maintained its special

* In America an explosive is fairly frequently used which more or less corresponds to the substance which Nobel patented in 1863 in Sweden and several other countries, and which goes by the name of "Judson powder" (Judge Judson was one of the first persons interested in the Giant Powder Co.). Judson powder consists of a kind of black powder containing sodium nitrate instead of potassium nitrate, as well as nitro-glycerine. Nobel had been advised to apply for the patent in question in the U.S.A. as well, but he refused to do so, since he did not in this case regard himself as being the *sole* inventor (American Patent Law requires an oath to be taken to that effect). He clearly held the view that his brother Emil had assisted in working it out.

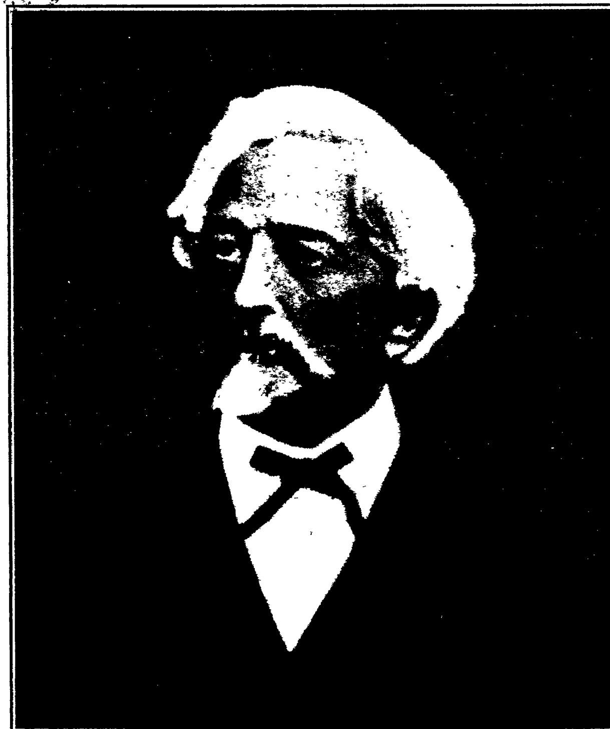
position as the only explosive used in certain Swedish mines, where the nature of the rock made it highly desirable to use a particularly powerful explosive. Nobel accordingly continued to work at the discovery of an explosive which would combine the high power of nitro-glycerine with the comparative safety in handling of dynamite. His efforts were crowned with success when in 1875 he discovered blasting gelatine, a collodial solution of nitro-cellulose in nitro-glycerine.

This discovery of Nobel's, according to the story frequently retailed in technical literature dealing with the subject, has also been ascribed to a pure accident. Nobel is supposed to have accidentally mixed nitro-glycerine with a collodion solution whereby a gelatinous mass was spontaneously formed. According to Nobel's verbal and written statements, constantly repeated, this story has no foundation in fact. Nobel's version of the course of events was as follows. He had already thought of using a mixture of guncotton and nitro-glycerine, and indeed such a mixture is mentioned in his first nitro-glycerine patent; but the absorbent capacity of ordinary guncotton proved inadequate for nitro-glycerine, and he failed to produce a solution of such guncotton in nitro-glycerine.

One day when working in his laboratory he cut his finger and applied collodion to the wound. The pain in his finger kept him awake at night and he lay pondering over the problem which was always in his thoughts; how to find a suitable means of combining guncotton with nitro-glycerine. He hit upon the idea that this might possibly be done more successfully with nitro-cellulose of low nitration such as the collodion which he had just used. He went down to his laboratory at four o'clock in the morning and when his assistant Fehrenbach arrived at the usual time Nobel was able to show him the first specimen of blasting gelatine which, in accordance with the methods which he usually adopted



ALARIK LIEDBECK



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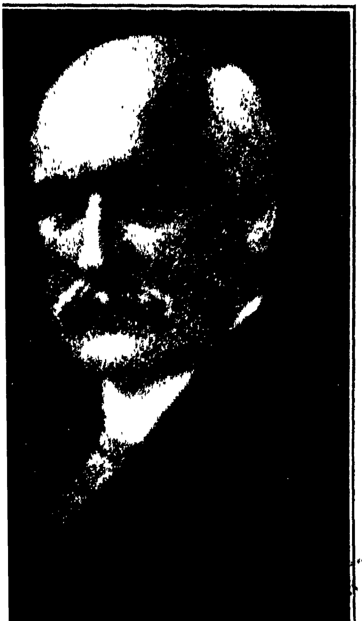
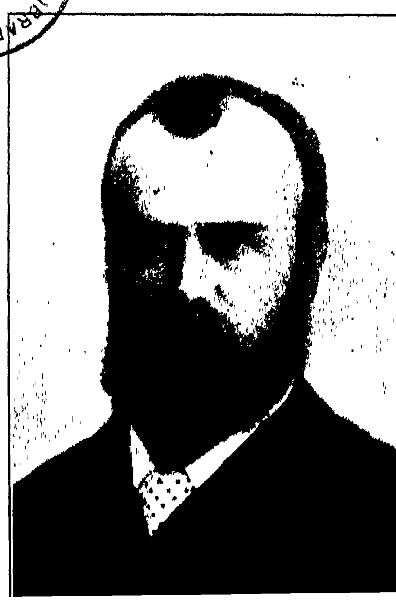


RAGNAR SOHLMAN

PAUL BARBE



when mixing explosives in his laboratory experiments, had been produced in a flat glass vessel. It consisted of nitro-glycerine with the addition of a small proportion of a solution of nitro-cellulose in ether alcohol.

From the technical point of view this was not a complete solution of the problem; a great deal of work remained to be done to ascertain, with reference to the degree of nitration, the gelatinising capacity, etc., the most suitable quality of nitro-cellulose for the new process. Moreover apparatus had to be constructed for manufacturing explosive gelatine on a large scale.

For the solution of the first problem Nobel carried out in his laboratory a great number (over 250) of different nitrating experiments with cotton wool and other kinds of cellulose; these experiments were continued on a larger scale in the individual factories that produced the new material.

The necessary apparatus was constructed by Liedbeck, who also, together with Fernbach, directed the production of the new explosive at Paulilles, Avigliana, Ardeer, Schlesbuch, etc.

Blasting gelatine could be produced in varying consistencies, according to the proportion of nitro-cellulose which it contained, the usual proportions being 7 per cent, 3 per cent and 2.5 per cent; it was thus possible to produce a firm, rather stiff jelly, or a plastic, semi-liquid mass. In its latter form it was used as the basic material for mixing with nitrates and hydrocarbons in the production of explosives which were called "extra"-dynamite, gelatine dynamite, gelignite, etc., and combined consistency with cheapness and effectiveness. Pure blasting gelatine (containing about 7 per cent of nitro-cellulose) may in several respects be described as an ideal explosive. Its composition is such that it is consumed entirely and reduced to gaseous products without producing either excess or deficiency of oxygen. It is actually somewhat more powerful than

pure nitro-glycerine. It is remarkably insensitive to shock, and also safe in other respects, as for instance when lit, while water has no effect upon it at all. The use of pure blasting gelatine is, however, restricted on account of its price, which is comparatively high, and for this reason it has been practically confined to submarine operations. In most countries the other kinds of gelatinous explosives mentioned above have now almost entirely superseded kieselguhr and other kinds of dynamite containing no nitro-cellulose, for ordinary blasting operations.*

Blasting gelatine and gelatine dynamite immediately became fairly popular in Switzerland, Italy and France. It has been calculated that the use of blasting dynamite instead of kieselguhr dynamite in the construction of the Gotthardt Tunnel meant an enormous saving in labour and expense.

The explosive authorities in England were at first exceedingly sceptical with regard to the question whether gelatinised explosive could be regarded as comparatively safe. In 1879 the production of these explosives was begun by way of experiment, but it was abandoned by order of Major Majendie, chief-inspector of explosives, and it was not until 1884 that the question of safety was considered to have been so far satisfactorily determined that final licence could be granted for the production and sale of blasting gelatine and gelatine dynamite.

Nobel had already considered how blasting gelatine could find extensive use as a military explosive, for the charge in shells, etc.

Numerous experiments in this direction were made, partly by him and partly by others; in England, for instance, under the direction of Professor, afterwards Sir Frederick, Abel. These experiments did not lead to any practical results at the time, as blasting gelatine was not sufficiently insensitive to blows for these

* It is only in America that on account of their greater cheapness those kinds of dynamite that have an active basis (*e.g.*, 40 per cent nitro-glycerine combined with a mixture of sodium nitrate and sawdust), are still fairly extensively used.

purposes, and was too liable to undergo changes while stored. It would seem, however, that the experiments helped in their way towards the achievement of Nobel's next important discovery, namely ballistite, or almost smokeless nitro-glycerine powder.

In that interesting and well-written paper previously referred to, which Alfred Nobel read before the Society of Arts in London on the 21st May, 1875, he describes the properties required in an explosive suited for practical use, and the advantages and defects of the black powder which had been used through the centuries, in the following way:

"It is not sufficient, indeed, that a substance is explosive, or even powerfully explosive, to render it useful for practical purposes. There are a great many other questions which have to be considered; in the first instance, whether it compares favourably with those substances already in use which it has to compete with; again, if the same power can be lodged in the same bulk; what the cost of manufacture is, and what danger or difficulties attend it; whether it offers the necessary chemical stability in all climates; whether its carriage and use are not too dangerous for its practical utilisation; whether it is hygroscopic, and how it is affected by contact with water; and finally, what influence the gases or fumes produced by the explosion may have on the health of the miners.

"This explains why it is difficult, even with more powerful explosives at command, to supersede gunpowder. That old mixture possesses a truly admirable elasticity which permits its adaptation to purposes of the most varied nature. Thus, in a mine, it is wanted to blast without propelling; in a gun to propel without blasting; in a shell it serves both purposes combined; in a fuse, as in fireworks, it burns quite slowly without exploding. Its pressure, exercised in those numerous operations, varies between one ounce (more or less) to the square inch, in a fuse, and 85,000 lbs.

to the square inch in a shell. But, like a servant for all work, it lacks perfection in each department, and modern science, armed with better tools, is gradually encroaching on its old domain."

Nobel had already succeeded in invading one of the fields in which black powder had hitherto reigned supreme, namely, that of rock blasting; he now devoted himself with the greatest interest to another field, that of ballistics, i.e., the production of smokeless powder for firearms and guns.

Towards the end of the 'eighties this problem was a burning question in several European countries. It had been necessary to give up the earlier attempts, including those of General Lenk in Austria, to use non-gelatinised guncotton as a substitute for black powder. In Germany Captain Schulze had succeeded, as early as the 'sixties, in producing a powder of nitrated sawdust that had been treated with a solution of nitrates, etc. The Schulze powder, as well as the closely allied E.C. powder manufactured in England, was, however, confined to sport, and was unsuitable for military purposes. In France Vieille had been working since 1884 on the production of the first types of gelatinised nitro-cellulose powder, his experiments being carried out in complete secrecy. In Germany Duttenhofer was making similar experiments, while in Sweden the smokeless powder known as apyrite or grey powder was discovered by Skodlund, and so on.

Alfred Nobel pursued an entirely new line. In 1887 and 1888 he patented a smokeless powder which he called ballistite, and which consisted of approximately equal parts of nitro-glycerine and nitro-cellulose, with an addition of 10 per cent of camphor.

The discovery that by a combination of two explosive substances, nitro-glycerine and guncotton, either of which alone will produce a powerful explosion, a powder of an entirely new type could be created, which could not be caused to explode in the proper sense of the word, but which, on being ignited, burnt with almost mathe-

matical precision in equal concentric layers (at a rate of combustion, we must not forget, that varied with the pressure) was regarded at the time as a highly sensational event, and indeed the first reports regarding it were received with a certain scepticism in professional circles. Such amazement was not lessened when it was learned that the new combination could be pressed between steam-heated rollers and, when heated, could be moulded into cords or tubes, etc.

As has already been indicated, blasting gelatine was the starting point of this discovery. In the records of Nobel's Paris laboratory, we find as early as the 15th April, 1879, a list of certain powder compounds containing both nitro-glycerine and nitro-cellulose, the latter consisting both of the so-called "insoluble" type (i.e. guncotton) and of the "soluble" type, (i.e. collodion cotton). Some of these compounds are given below:

1. 1 part n. (= nitre)
   8 parts nitro-glycerine.
   5 parts "coton Abel" (guncotton).
   1 part nitro-benzin

   15 parts.

2 1 part nitro-benzin.
   4 parts nitro-glycerine.
   2.5 parts soluble nitro-cellulose

   7.5 parts.

It would appear that these compounds did not give satisfactory results, for Nobel's next experiments were carried out on quite

different lines, with picric acid, compressed guncotton, nitrated "corrozzo" (a kind of vegetable fibre), regarding which the laboratory journals for the following years have numerous entries.

It was only after a closer study of celluloid, which had otherwise aroused Nobel's interest, and given him suggestions for new ideas, that he hit on the line which finally led him to success.

In his first patent applications dealing with ballistite, in the year 1887, Nobel himself suggests that this was in his mind. In his application for the provisional patent he says:

"The substance known by the name of celluloid usually consists as to two-thirds of its weight of nitrated cotton wool, but, owing to the camphor content and to its close consistency, the combustion of celluloid, even when it is finely granulated, proceeds too slowly to make it serviceable for projectiles. Experiments have shown that, by wholly or partially substituting nitro-glycerine for the camphor, a kind of celluloid can be produced which is of sufficient consistency to assume the right granular character, and which is consumed at the right speed when used as a charge in firearms to enable it to be employed as a substitute for black powder over which it has the following advantages: it develops greater power, leaves no residue, and is smokeless, or very nearly so."

It was natural that this discovery should attract considerable attention in all military circles, and arouse the interest of various governments, as they were all somewhat nervous lest they should drop behind other countries in their military preparedness through some new invention. The introduction of smokeless powder, especially, might be expected to have far-reaching and almost incalculable results in its influence upon tactics. Nobel was made aware, in various ways, of the interest taken in the work on which he was engaged.

The Italian Government was the first to decide to introduce ballistite, or Nobel powder, as the substance came to be called in

Sweden. A large section for the manufacture of Nobel powder was added to the factory at Avigliana, and the first important contract for the delivery of 300,000 kilogrammes of ballistite was concluded as early as the 1st August, 1889, between the Italian Government and Nobel's representative Ristori. The powder was to be made at Avigliana, and Nobel was to receive certain royalties on the selling price.

The Italian Government wished to acquire the rights of manufacturing ballistite itself, and on the 16th September, 1889, an agreement was concluded, under which it acquired the right to exploit Nobel's patent, in return for a payment of 1.45 francs per kilogramme manufactured.*

This agreement caused some dismay in France. Certain influential circles connected with the administration of the powder monopoly—*l'administration des Poudres et Salpêtres*—in that country had for some time been keeping a hostile and suspicious eye on Nobel's activities, as likely to interfere with the new French smokeless powder, which had been worked out by Vieille, and which at this time was being introduced into the army and the fleet for training purposes. A fierce newspaper campaign against Nobel was set in motion, and he was accused, amongst other things, of spying on the experiments in the Monopoly Administration's Laboratory which, like Nobel's, was in Sévran-Livry.

The result was that Nobel's laboratory was searched by the police, and finally closed; moreover he was forbidden to carry out shooting experiments on the site which had hitherto been placed at his disposal for short periods, and to which Nobel had had some small cannon brought for his experiments, as well as various kinds

* Under a later agreement the Italian Government compounded for its obligation to pay further royalties by a single payment of 500,000 lire.

of firearms in use in the army. Similarly all manufacture of ballistite in the factory of the French Nobel Company at Honfleur was prohibited, and a small quantity of experimental powder which was already made, was confiscated.

The result of all these annoyances was that in 1891 Nobel transferred his residence and his laboratory to San Remo.

His discovery of ballistite was to cause Nobel worry and disappointment in other directions. His work in the field of military explosives had been followed with interest in England too. In the 'eighties Nobel had formed a really intimate friendship with Professor Abel, his former opponent in the dynamite question; they carried on a correspondence over a period of years on technical matters, and met occasionally in London and Paris. Nobel had also come into personal touch with Professor Dewar, a well known English physicist and a friend of Abel. In 1888 the British Government appointed an Explosives Commission to investigate new discoveries, especially such as affected the use of military explosives, and to submit to the War Office proposals for the introduction of any technical improvements in this field, that the Commission could recommend. Abel and Dewar were members of this commission, and as such they communicated with Nobel, and requested him in confidence to give the Commission the fullest information possible regarding his new powder, and any recent developments affecting it. This he did, and for about a year, from the autumn of 1888 until approximately the autumn of 1889, the Commission was in the closest touch with Nobel, who carried out tests, and gave precise information regarding the composition and the manufacture of the powder.

The Commission raised certain objections against ballistite in its original form, and against the method of manufacturing it. One objection was concerned with the fact that it contained camphor, it being submitted that the volatile nature of that substance made

it unsuitable. Nobel therefore suggested other ingredients such as acetine and similar substances. Moreover the committee did not consider the use of so-called soluble nitro-cellulose as particularly advantageous, since the types of nitro-cellulose involved were changeable in their composition. On the proposal of Abel, "the distinguished advocate for guncotton" as Nobel had called him as early as 1870, and of Dewar, experiments were made instead with highly nitrated so-called insoluble guncotton, which resulted in the production of a kind of powder containing 58 per cent nitro-glycerine, 37 per cent guncotton and 5 per cent vaseline which, with the assistance of a volatile solvent acetone, was reduced to gelatine. The mass was then pressed in strips or cords, hence the English name cordite. After pressing, the acetone was eliminated by drying.

Abel and Dewar now proceeded to patent this modified form of nitro-glycerine-nitro-cellulose powder both in England and in several other countries. The English patent rights were made over to the British Government, the vendors retaining their rights in the foreign patents which they afterwards duly exploited.

The fact that the new powder had been patented was at first kept secret; and strangely enough the commission kept in touch with Alfred Nobel, who informed them of the further progress that he made. After negotiations for a kind of joint interest in the discoveries of both sides had proved fruitless, the collaboration was brought to an end and the British War Office decided, on the advice of the commission, to arrange for the manufacture of cordite in accordance with Abel's and Dewar's patent, and to introduce the powder into the British Army and Navy.

Nobel's Explosives Company, which had acquired Nobel's ballistite patent, regarded this as an infringement of their patent, and protested. After fruitless negotiations it was decided to submit the

matter to the courts in the form of a so-called "friendly suit." The case, which attracted great attention at the time, and was the subject of lively comment in the British press, was heard between 1893 and 1895. The suit was carried further, to the Court of Appeal and to the House of Lords, and ended by the Nobel company losing its claim for compensation against the British Government. The plaintiff, Nobel's Explosives Company, was also compelled to pay the costs of the suit, which amounted to the considerable sum of about £28,000. The ground for refusing to admit Nobel's prior claim in the discovery of cordite was that in his patent application in respect of ballistite he had specially prescribed the use of nitro-cellulose "of the well known soluble kind," a somewhat indefinite expression which was variously interpreted by the experts, while the court held that it excluded anything which at the time of the application could have been considered as being of the nature of "insoluble" guncotton.*

During the hearing of the case it was, however, generally admitted that Nobel's work had been of revolutionary importance in this field too. One of the judges, Lord Justice Kay, expressed his grave doubts regarding the material justice of the decision of the Court of Appeal, although he felt it his duty to concur in it on technical grounds, by an exceedingly apt image. He stated in the course of the proceedings:

"It is quite natural that a dwarf on the shoulders of a giant should see further than the giant. One cannot help feeling sympathy with Mr. Nobel, who has made a grand invention. He has arrived at a new and most useful result, and when other persons have arrived at substantially the same result their methods should be closely examined to see whether they have infringed the patent."

* The plaintiff showed in the course of the proceedings that what had hitherto been regarded as "insoluble" guncotton could in certain circumstances be soluble.

Lord Justice Kaye pointed out that Nobel's discovery involved a really important new principle, and that two clever chemists, having carefully read through the specification, had, by using the same materials, although in a slightly different manner, produced precisely the same result. His Lordship would gladly have been able to reach a conclusion by which it would not have been possible to deprive Mr. Nobel of the benefit of his patent.

To this the Attorney-General responded: "Upon our construction we do not take away anything from him. I do not wish to be misunderstood. . . . I do not wish to run down Mr. Nobel in this matter at all." Lord Justice Kaye: "I do not think you could, if you tried, because it seems to me what you have done is the greatest possible compliment to Mr. Nobel."

Nevertheless, Lord Justice Kaye felt himself bound to join with the other judges on technical grounds to uphold the judgment against the plaintiffs. The same judgment was confirmed in 1895 by the House of Lords.

The result of the case produced some very strong comment in the press, and both the War Office and the Government were subjected to exceedingly severe criticism in many quarters.*

Alfred Nobel bitterly resented the verdict, a fact which may have severely affected his health. The actual loss of money was a comparatively subordinate consideration; he grieved above all at the injustice he had suffered, as well as at what he felt to be a disgraceful lack of appreciation of his achievements as a discoverer, a matter on which he was always somewhat sensitive. He thought

* The case aroused considerable public feeling at the time. An interesting leading article appeared after the first trial in *The Times* of 15th February, 1894. Mr. Campbell Bannerman, answering a question in the House of Commons, said that the Government were anxious that Mr. Nobel should have every consideration.

In the House of Lords the Lord Chancellor had little to say beyond confirming the judgment of the Court of Appeal, and the other judges sitting with him simply concurred in his opinion. Mr. Justice Romer's judgment is given in Appendix I.

at one time of giving vent to his feelings in a long letter to the British War Office in which, after reciting the facts leading up to his application he would ask the British Government for one guinea as compensation, and as a recognition for his services in the solution of the problem of explosives. It would seem, however, that his English legal advisers prevented him from sending this letter. He also wrote a dramatic parody describing an English patent action, under the title, "The Patent Bacillus," which had obvious references to the cordite case, and the persons who had played a part in it. Nobel's private correspondence of the period immediately after the case also shews how he was affected by the result. He writes in a letter to one of his English friends, dated the 11th April, 1895:

"People say that there's no use crying over spilt milk; nor do I, but there is something in grievous injustice, when committed by the State, which very much revolts my feelings. A sane sense of right and wrong should not rise from the mob to the Crown, but ought to spread downwards from the summit . . . Just fancy a poor inventor having to spend £28,000 in a 'friendly' suit meant to establish his right!"

During the century after Nobel's discovery of smokeless nitroglycerine powder, this type of powder was introduced in various countries for the use both of the army and of the navy, or in certain cases, only for naval guns. Amongst the countries that introduced Nobel powder were Italy, Germany, Austria-Hungary, Sweden and Norway. England, Japan, and certain South American States introduced cordite, while France, Russia and the United States preferred nitro-cellulose powder, of a type based more or less upon Vieille's original invention.

Nobel drew substantial royalties for many years in those countries where Nobel powder or ballistite was manufactured. Nobel's

Explosives Company, which undertook the manufacture of cordite, both for the account of the British Government,* as also for export, under a separate agreement concluded with Nobel, paid him a certain sum on the cordite manufactured, which was equivalent to about half the royalty payable in respect of each kilogramme of ballistite manufactured. Thus, in the end, Nobel did actually receive some compensation also for his patents in England.

Alfred Nobel's final discovery concerning explosives was the so-called smokeless progressive powder. A detailed description of this discovery would require technical details in ballistics, such as hardly come within the scope of this biography. It will be sufficient to state that the purpose of the invention was to increase the muzzle velocity of projectiles, without increasing the maximum pressure within the weapon, and to do so by inducing a certain increased progressiveness in the burning of the powder, whereby the pressure is maintained as the projectile moves along the bore, and the total ballistic effect is increased. This progressive consumption of the powder is achieved in two ways: mechanically by a progressive increase in the surface area of the powder pellet during the process of combustion, and, chemically by the composition of the individual powder pellets of various layers being arranged in such a manner that the rate of combustion is greater for the internal layers, and therefore increases as the combustion proceeds.

These two methods for the production of progressive powder were the subject of extensive experiments carried out in the years 1895 and 1896, in Nobel's laboratory at Björkborn. Under the earlier method Nobel powder was produced in the form of thick strips or discs perforated with hexagonal holes whereby they acquired the appearance of honeycombs. During the process of

* Other firms also manufactured cordite, and the War Office built its own factory at Waltham Abbey. In these cases of course Nobel received no royalty.

combustion the total internal surface of the holes became greater and thus the desired "progressivity" was produced and in the tests that were carried out the muzzle velocity of the projectile was increased. The method of manufacture was, however, somewhat primitive, and did not make it possible to produce comparatively equal results in the tests, so that it was abandoned provisionally.

The same idea was, however, afterwards adopted by the American inventors Maxim and Schüpphouse, who produced a so-called multi-perforated nitro-cellulose powder, which was introduced into the United States Army and Navy and into a number of other countries.

Nobel was still more keenly interested in the other, i.e., the chemical method of manufacturing powder that acted progressively, and he patented this invention, too, in several countries. He did in fact succeed, in this way, in producing types of powder which yielded particularly high initial velocities at a low pressure. The various rates of combustion of the individual layers making up the powder discs or powder tubes were achieved by differences in the content of nitro-glycerine, and also by adding to the external layers a so-called damper substance, i.e., a non-explosive and non-liquid solvent of nitro-glycerine and nitro-cellulose. This invention also was not practically used in original form; for it proved that the powder manufactured in this manner changed its nature while stored, since the various layers interacted upon one another. Further extensive attempts to deal with this problem were cut short by Alfred Nobel's death. Meanwhile this invention too has been adapted to practical requirements in a modified form, and so-called progressive nitro-cellulose powder, which was first tested in Germany, and the production of which is based upon the principles mentioned by Nobel in his patents, has now been introduced for the infantry firearms of several states.

Before we close the description of Alfred Nobel's activities as

founder of the modern explosives industry, it may be relevant to say a few words about the men who were his principal collaborators, apart from his father and his brothers, Emil and Robert, whose share in his work has already been mentioned.

A couple of young engineers, by name T. H. Rathsman and A. E. Rosengren, were the original factory managers appointed by the nitro-glycerine company. The former was in charge of the manufacture on the punt in Bockholmsund. His daily reports of February, 1865, are still available, and they contain a number of eloquent details regarding the dangers and difficulties under which the work was carried out. He seems to have resigned his appointment with the nitro-glycerine company during the following year, and to have been engaged by a chalk and slate quarry near Kinnekulle, where he introduced the use of nitro-glycerine. In 1867 or 1868 he succeeded Dittmar as factory manager at Krümmel, and assisted Alfred Nobel to start the manufacture of kieselguhr dynamite. He was killed by the explosion of the 29th May, 1870, which entirely destroyed the nitro-glycerine factory at Krümmel. The cause of the explosion seems to have been a rapid generation of heat and inadequate application of water cooling. At that time people were comparatively inexperienced regarding the dangers connected with the separation of nitro-glycerine from residuary acids.

Alarik Liedbeck succeeded Rosengren in 1866 as factory manager at Winterwik; of Nobel's colleagues his name is associated above all with the purely technical development of Nobel's inventions. Liedbeck worked with Nobel for thirty years, first as factory manager, then as a factory designer of real genius, and finally as a consulting engineer to the various dynamite factories. During these years the manufacturing and technical details of the production of nitro-glycerine, dynamite and ballistite were essen-

tially under his control, or at any rate worked out with his collaboration. Amongst the machines and apparatus generally introduced and used in the explosives industry, we must particularly mention the air injector for the nitration of glycerine, the dynamite presses, gelatinising apparatus for blasting gelatine, as well as rollers and presses for smokeless powders.

A factory manager at that time certainly needed great moral and physical courage to work with the new explosives, and still more so to introduce new apparatus and methods of work, whose practicability and safety could only be tested by experiments which were naturally associated with grave risks.

Liedbeck held the appointment of engineer at Winterwik from 1866 to 1875, and during that period witnessed two considerable explosions, in 1868 and 1874. The latter explosion had been caused by a fire on a steamer, which had taken on a cargo of saltpetre. Owing to Liedbeck's efforts the effects were much less serious than they would otherwise have been. While the factory where the nitro-glycerine was cleaned was burning, Liedbeck, with the assistance of a couple of workmen, carried out the nitroglycerine that was in it, and brought it into security—a manifestation of courage and presence of mind that earned the gold medal for "meritorious deeds." This was indeed the only public recognition that Liedbeck, who was an exceedingly modest man, received in the course of his life.

Liedbeck's later work as "ingénieur du Syndicat des fabriques de Dynamit" has already been referred to. He had a thorough practical and theoretic knowledge in various branches of the subject, which he was able to turn to practical account by the publication of a dictionary of chemical terms, on the lines of Wagner's German work. Liedbeck invented apparatus in various other fields besides that of explosives; thus, together with his brother, who was a physical training expert, he designed the well-known massage

vibrator. It was only increasing ill-health that forced him to give up work during the last years of his life. He died in 1912.

During the years of his prime Liedbeck was in many respects the embodiment of the best qualities of a brilliant engineer and factory manager. He was indeed appreciated everywhere on account of his personality and his capabilitities, and he was loved in the circles with which he came into touch both in Sweden and abroad. Barbe, especially, who was in many respects an entirely different kind of character from Liedbeck, had an extraordinary regard for him.

In expenditure on apparatus Liedbeck was not at all inclined to be cheeseparing; his estimates and the accounts which he passed sometimes aroused the misgivings of Nobel and Barbe, who were very keen on economy; but it became the custom to terminate any further discussion with the remark: "C'est Liedbeck—faut bien payer!" Until their death Liedbeck was on the most excellent terms with both Alfred and Robert Nobel. Although, as a result of his increasing deafness, his meetings with Alfred Nobel became less frequent as the years went on, their friendship was kept alive by correspondence. Nobel's last English patent, which was granted after his death, and the subject of which was a progressive nitro-cellulose powder, together with the apparatus for manufacturing it, had been applied for jointly with Liedbeck, who had constructed the apparatus.

In spite of his long residence abroad, Liedbeck was always a typical Swede; and this is not surprising, for he was a grandson of Per Henrik Ling, the "Gothic" poet, more generally famous as the founder of the system of physical exercises called after him.

We find a number of other Swedes amongst the pioneers in the explosives industry which grew up on the basis of Nobel's discovery. Theodor Winkler, Alfred Nobel's partner, although he had no real

fame as an engineer, seems to have had certain natural mechanical gifts, and assisted Nobel in technical details during the years 1865 to 1867. On the 27th September, 1867, he died of typhus in San Francisco, to which town he had gone in connection with the negotiations for starting the manufacture of dynamite. Carl Amark who built the dynamite factory at San Francisco in 1870, and started its operations, has already been mentioned. In 1875 Amark succeeded Liedbeck as factory manager at Winterwik, remaining in that post for eight years, until ill health forced him to retire. Afterwards he was in charge for some years of the plant of the dynamite factory at Grängesberg.

C. O. Lundholm, the consulting chemist and factory manager at Ardeer, has also been referred to. With his colleague, the Scottish chemist, J. Sayers, he had much to do with the development of the manufacture of explosives.

There are a number of other Swedish engineers whose names might well be mentioned amongst the pioneers in the explosives industry. "La Swede est le pays classique des explosives," says the Frenchman P. Challons in his treatise, "Les explosives modernes." Alfred's epoch making discoveries and their success did in fact arouse keen interest for this branch of science in his country, and for many years the explosives industry provided one of the principal openings for young graduates, who had completed the course in chemistry at the Technological Institute, later known as the Technical High School.

Among the technical leaders of other nationalities who may be considered as pioneers were: *McRoberts, the first manager at Ardeer; Hoffer, an Alsatian, who built the factory at Isleten in

* McRoberts was for many years closely connected with Nobel and contributed in various ways to the development of the new industry, and more particularly to the growth and improvement of the Ardeer factory. An interesting description of the Ardeer factory as it appeared a year after the start is given in Appendix II, and affords a close idea of the conditions under which the new industry had to work.

Switzerland, and was afterwards manager for several years at Avigliana in Italy, being finally appointed by Barbe as technical manager at Krümmel; Trauzl in Austria; and Galinié and Abelli, two Italians who succeeded one another as managers at Avigliana.

In addition to these, the name of Geheimrat Dr. Aufschläger must be mentioned; for many years he played a leading part in the explosives industry of Germany, both from a scientific and an administrative point of view. Dr. Aufschläger, who was also one of the leading spirits in the I.G. Dye Trust, has given his own account of his early connection with the explosives industry, from which we quote the following extracts:

"It was in 1879 that I first had anything to do with dynamite; I was at the time a lecturer at the Technical High School in Dresden, and the State copper and coal mines in what was then the kingdom of Saxony, used to send me the samples produced by the various factories before they concluded their agreements for dynamite, basing their decisions on my analysis.

"I therefore acquired a certain practice in the handling of dynamite, and this caused my professor, Geheimrat Dr. Schmitt, who was the chemical expert attached to the Saxon Ministry of the Interior, to suggest me as a suitable person to deal with the problem of destroying a considerable quantity of dynamite which had been lying for some years in a deserted mine near Berggiesshübel. In due course I was entrusted by the Ministry with the task of destroying the dynamite in the least dangerous manner possible. A preliminary investigation of my task revealed the fact that about 80 cwt. of dynamite were lying at the foot of a shaft, the opening of which faced the small town of Bergiesshübel, and that damp had so far caused it to decompose that a considerable part of the nitroglycerine had run out, and had adhered to the cases in a thick crystal crust.

"In view of the large quantity involved, I felt that it would be too elaborate to try to decompose the nitro-glycerine or dynamite by chemical means. I therefore decided to destroy it by burning and, after making a few experiments, I had a number of incinerators built on a deserted heath, and threw the dynamite or nitro-glycerine into them when they were burning brightly. I took the precaution of sending my men away after they had brought out of the shaft the stuff that was to be destroyed on any particular day, and then saw to the burning of it myself. I had to take the crusted nitro-glycerine out of the boxes with bare hands, actually having to scratch it out, and the close contact with nitro-glycerine produced the usual physical reaction, so that I suffered from almost intolerable headaches, which made it almost impossible for me to complete my task. After ascertaining by an experiment that crystallised nitro-glycerine, on being struck with a hammer on an anvil, exploded only after being first liquefied by the blow, I proceed to empty the contents of the cases, i.e., dynamite and nitro-glycerine, with a coal shovel, and then to transfer them to the incinerators. Violent explosions did occasionally occur, and they burst several incinerators, but I was not hurt, and after having completed my task, which I succeeded in doing without any accident, I received a letter of appreciation from the Minister of the Interior.

"This task had aroused my keen interest in dynamite, and I proceeded to make enquiries regarding its production and its sale. The Erz Mines in Saxony were at that time still of considerable importance and required a large amount of dynamite. Apart from a few factories making black powder there were at that time no works manufacturing explosives in Saxony, a fact which led me to decide to build a dynamite factory in the heart of the mountainous part of Saxony, a decision which was all the more congenial to me since I had recently become engaged and wished to make myself financially independent.

" After losing much time over several fruitless attempts to find a suitable site for such a factory, I succeeded on the 7th January, 1882, in acquiring a piece of ground from the Mines Department of Saxony, and in obtaining from the District Commissioners at Freiburg the concession to build and run a dynamite factory. In my efforts to find a suitable site I was particularly assisted by Le Maistre, who was Chief Constable at the time, and afterwards Commissioner of Police in Dresden, and by the President of the Mines Department, Geheimrat Merbach, and I am particularly grateful to them for their help.

" I was enabled to built the factory so speedily that the first dynamite was sent out from it on the 23rd June of that year. It answered exactly to the requirements of the consumer, and the Freiburg Copper Mines were glad to be able to draw their substantial requirements from a neighbouring factory which endeavoured to meet their wishes in every way. The result was that the new factory was kept busy, and was enabled steadily to increase its output.

" Meanwhile a company had been formed in Dresden called the *Dresdne Dynamitfabrik A.G.* which built a factory near Dresden. Great difficulties arose, however, in the course of its operation, and these seemed to be insuperable; a conflict arose between the technical and the commercial management which caused the board of the company to approach me with the suggestion that the two undertakings should be amalgamated and that I should preside over the combination. After demurring for some time I agreed to this proposal, being influenced in my decision by the fact that I had heard that, in the event of my final refusal, the factory would be offered to the *Dynamit-Aktien-Gesellschaft,* formerly Alfred Nobel and Co., Hamburg. The competition at close quarters of the *Dynamit-Aktien-Gesellschaft,* which was already a powerful company, would have been highly prejudicial to my concern.

"In the autumn of 1884 I went to live at Dresden, and handed over the management of the factory to a Norwegian, Olaf Hansen.

"I had been exceptionally fortunate while I was in control, since there had not been an accident of any kind in the factory during that time. There was one occasion when there was imminent risk of a serious explosion; I saw thick red vapour issuing from the windows, doors and exits of the nitro-glycerine washhouse. This meant that the nitro-glycerine had begun to decompose. I hurried to the spot and cleared the workmen out and, by means of an intensive application of air and water cooling I succeeded in arresting the process of decomposition.

"At that time, i.e., in 1884, there were the following nitro-glycerine factories in Germany: the Dynamit A.G., Hamburg, with their factories in Krümmel and Schlebusch; the Rheinische Dynamit Fabrik, Cologne, with their factories in Opladen and Mansfeld; the Deutsche Sprengstoff A.G., with their factory in Altberun; the Siegener Dynamitfabrik, Cologne, with their factory in Foerde; and finally the Dresdner Dynamitfabrik, Dresden, with their factories in Muldenhütten and Radeberg. Keen competition prevailed, and after many fruitless efforts the first German Convention was held in the spring of 1884.

"The Convention gradually produced a friendly relationship between the first three of these companies, which formed themselves into the so-called German Union, and proposed to the Dresden Dynamite Factory that it should join them. This proposal was accepted, and the profits were divided according to a prearranged scheme.

"Although this Convention settled the problems of the explosives within the German Empire, the competition in the export trade became more and more keen. The two main rivals were the German companies on the one hand and Nobel's Explosives Company, Ltd., of Glasgow, Australia, South Africa and England

on the other hand. As, at that time, any agreement of the nature of a cartel, or agreement for fixing prices, was not enforceable under English law, the plan was adopted of uniting the companies into a trust company. The shareholders of the four German and of the English company were asked to exchange their shares for shares in a holding company, to be called the Nobel Dynamite Trust Company, Ltd., and almost all the shareholders, with only a few exceptions, concurred in this proposal, so that in October, 1886, the Nobel Dynamite Trust Company, Ltd., with its registered offices in London, was able to commence operations with Alfred Nobel as its honorary chairman."

CHAPTER VIII

OTHER INDUSTRIAL DISCOVERIES AND INTERESTS

ALFRED NOBEL'S inventive efforts were by no means limited to the field of explosives; and it has not been possible in a summary narrative dealing only with the more remarkable of those of his discoveries which have been applied in practice, to treat exhaustively his work in that particular field.

Nobel had, to an exceptional degree, what is essential to an inventor, the gift of imagination. He had, not merely the capacity, but a positive urge, to give forth original ideas. His imagination ranged over the most varied fields; apart from applied chemistry, he interested himself in electricity, optics, machinery, gunnery, biology and physiology, to mention only the applied sciences.

As in the case of his father, his imagination frequently became purely fantastic. Sometimes this was deliberate, as when he would break in upon a serious business discussion with an account of some bizarre invention; but in such cases he often did so in order to throw dust in the other people's eyes, and to gain time to reflect upon a ticklish problem.

As is not infrequently the case with inventors of genius, Alfred Nobel was not always able to distinguish between epoch-making discoveries and pure phantasies. This was apt to be especially the case when he was dealing with a subject in which his knowledge was superficial or amateurish, as for instance in certain questions affecting the construction of artillery, or in problems concerned with biology and physiology. A very large number of these

various ideas of Alfred Nobel, those in fact which are concerned with industrial inventions, have become crystallised in the numerous patents which he applied for and was granted in the course of time. It is not possible accurately to determine the number of these patents, but according to the approximate lists compiled for the purpose of dealing with his estate after his death, they amounted altogether to 355 in different countries. To give a detailed account of all the ideas, many of them exceedingly original, underlying these patents would make it necessary to cover too much ground, and might hardly be interesting. In order to convey some notion of the wide range of Nobel's inventive activities, a full list of his English patents is given on page 307. With this list is incorporated a short summary of the subject of each patent, so far as this has been ascertainable. Many of Nobel's English patents were registered merely as so-called "provisional patents," which have not been pursued further; in such cases it has only occasionally been possible to obtain the text of the application from Nobel's own notebooks.

Nobel's early scientific training seems to have been confined principally to mechanics and scientific apparatus. Towards the end of the 'fifties and thereafter he describes himself as a "Civil Engineer." His first three English patents have reference, as has been briefly indicated, principally to the construction of apparatus. His first patent, granted in September, 1857, concerned a gasometer, his principle being to measure the volume of water absorbed by the gas. In January, 1859, he was granted a patent for an apparatus for measuring water and other liquids, the principle being that a rod was introduced into the flowing liquid, consisting of a substance soluble in the liquid, and whose loss of weight could be ascertained; in March of the same year he was granted a patent for the construction of a barometer. None of these patents, however, came into practical use. During the

'sixties and the early 'seventies Nobel's inventive efforts were entirely concentrated upon nitro-glycerine and dynamite; but after he had built his Paris laboratory and engaged Fehrenbach as his private assistant, he began to occupy himself with a series of other technical and industrial questions. These were concerned partly with problems of special importance in the manufacture of explosives, *e.g.*, the concentration of sulphuric acid, cooling apparatus, the gasification of liquids, etc., and partly with the naphtha industry. The most noteworthy were his special oil-burners for oils of high specific gravity, and his process for the continuous distillation of naphtha. But his activities extended to quite different fields also; thus, in September, 1878, he patented an automatic brake in France, as well as an explosion-proof boiler (a kind of tubular boiler in the shape of a spiral, slightly conical tube for the production of steam), and in June, 1879, he patented in England a process for refining cast iron.

There are certain ideas to which Nobel constantly reverts in his experimental work, often after the lapse of considerable intervals. As we have seen, this was the case both with his blasting gelatine and ballistite, but it is also true of a number of other inventions which are not so well known. Such were his attempts to produce a fuse that would be impervious to water, with a core consisting of a plastic mass containing gelatinised nitro-cellulose, with the addition of salts rich in oxygen and combustible materials, and his endeavours to manufacture substitutes for rubber, leather, gutta-percha, etc., from nitro-cellulose that had been dissolved in suitable non-volatile and non-inflammable solvents. As we shall show, Nobel reverted to this problem shortly before his death. During the cordite case, in connection with his statement in the witness box regarding the manner in which he discovered ballistite, Nobel thus described his method of work:

"I worked intermittently; I left the matter alone for a time

and then took it up again. I work like that fairly often, but I always return to anything of which I have the feeling that I shall succeed with in the end."

During the second half of the 'eighties, Nobel was again working principally on explosives. Ballistite brought him fame, but his patent records and his laboratory diaries show that he was working at a number of other ideas and inventions. He endeavoured to construct a safe means of packing hygroscopic explosives, and worked at producing a detonator whose charge should consist of a less sensitive and a cheaper explosive than fulminate of mercury. In April, 1886, he proposed the use of liquid solvents containing a great deal of carbon for nitro-glycerine, instead of sawdust, in the case of dynamite and its variants, an idea which had already been adumbrated in 1875 in connection with the discovery of blasting gelatine, and which was of great practical importance and was afterwards extensively applied in the manufacture of such variants of dynamite as did not readily solidify.

A somewhat curious proposal forms the subject of two provisional applications for patents in England, put forward in the years 1885 and 1886, which deal with "an improved method of blasting rock by heat"! It is certainly strange to find the discoverer of dynamite contemplating a reversion to the highly primitive method of making a fire on rocks in order to break them up, a kind of variation of Hannibal's method for crossing the Alps, just as, in imitation of Hannibal's military tactics, Immanuel Nobel had conceived the idea of training seals to draw mines.

It appears from Nobel's notebooks that his idea was something as follows: After boring a hole in the rock in the usual way, a powerful burner consuming liquid or gaseous material should be directed into the borehole. This would heat the rock near the hole to such a degree that, if suddenly cooled by pouring water

over it, it would become quite brittle and would be easily excavated. Having thus made a considerably larger hole the operation could be repeated, and thus large masses of rock could be broken up.

From the period of the 'eighties onwards, possibly in connection with his work on ballistite, Nobel's interest tended to be centred more and more upon the problems connected with artillery and munitions, which, as he was wont to emphasise, had a particular fascination for him from the purely theoretic point of view. At the same time he kept on putting obstacles in the way of a practical application of these inventions.

The following ideas in the field of munitions which he worked out during this latter period are particularly worthy of mention. He endeavoured to construct a noiseless gun, as well as an expanding obturating band for projectiles to save the wear and tear of the bore, and made experiments with fuses for shells and rocket guns. He also tried to discover a process for the internal forging of gun barrels. The noiseless discharge of the bullet was to be effected by securing that immediately before the bullet left the muzzle, a sort of clack-valve should drop behind it, so that gases should be discharged through a silencer. These experiments were partially successful, but had no real practical value.

The expanding obturating band* was achieved by means of small powder charges laid in separate chambers in the back part of the projectile. The imprisoned gases necessarily pressed the copper lining forcibly against the bore of the gun, whereby a very high pressure of gases could be achieved. This invention proved perfectly sound in theory, but had certain practical complications and objections which prevented its being brought into actual use.†

* Swedish patent No. 7096 of the 19th January, 1895.

† Nobel discovered a really brilliant method for testing the value of an expanding copper band in lessening the wear and tear on the bore. In general, wear and tear increases in proportion to the calibre, and such wear and tear is caused by the heat produced by the charge. In order to carry out an experimental comparison under exactly similar

The idea of a "rocket projectile" or "aerial torpedo" originated partly with the then Captain (afterwards Lieutenant-Colonel) W. Unge, but Nobel made himself responsible for the expense of the experiments, and also devoted a good deal of attention to the solution of the problem. As the name implies, the projectiles, which consisted of long steel cases, were provided at their base with rockets, which were to supply the real propelling power. These projectiles were released and given their initial direction from a simple steel tube, partially slit. The rotary motion necessary to maintain the projectile in its direction was secured by bringing the exhaust gases to bear upon a kind of turbine at its rear. The intention was that these aerial torpedoes should be used, not only in war, but also for the rescue of shipwrecked persons. Fairly considerable trajectories were achieved—up to four kilometres—but they proved to be of doubtful accuracy, and the invention could not be applied in practice.

During his later years Nobel took an interest in a number of questions affecting industrial production, in addition to these military problems. We must specially mention his efforts, to which a short reference has already been made, to produce substitutes for rubber, guttapercha, leather and patent leather from nitro-cellulose dissolved by various non-volatile solvents. In the course of working out these problems at Nobel's laboratory at San Remo, and afterwards at Björkborn, the knowledge of nitro-cellulose solvents was very considerably increased. A number of these new solvents have acquired considerable practical importance, partly in combination with ballistite (to lower the temperature of

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conditions between projectiles with and without expanding bands without too great expense, Nobel had a "double cannon" made of a calibre of 8.4 centimetres, with a single powder chamber in the middle and two gun barrels from which two projectiles could be shot in exactly opposite directions, and under the same conditions as in an ordinary 30.5 gun, the recoil being eliminated. One of these projectiles was provided with an expanding band and the other not. A number of shots were fired from this double cannon, and the wear and tear was compared after the various rounds.

combustion and diminish the wear and tear of the bore) and partly as ingredients in modern varnishes. Indeed, this patent of Nobel's may be said to have pointed the way to the manufacture of such varnishes and stains as contain nitro-cellulose; while similarly, Nobel's discovery in this field, although it did not prove to be economically effective for the production of a rubber substance, did undoubtedly assist in the development of the manufacture of modern artificial leather, such as "pegamoid."

Another use of nitro-cellulose, in which Nobel interested himself at an early date, was the manufacture of artificial silk, and experiments on these lines were carried out in his San Remo laboratory in 1893 and 1894. He also patented special glass nozzles having holes of the requisite fineness for squirting the nitro-cellulose into the thin filaments of which artificial silk is made. The holes in the nozzles were made by melting fine platinum wires into the glass, these being then dissolved with *aqua regia*.

Later on Nobel commissioned and financed the design of a machine for the manufacture of artificial silk on the lines suggested by R. W. Strehlenert, an engineer, who was granted a patent for it. These experiments, which were continued after Nobel's death, did not prove successful; but they may be regarded as constituting a link in the development of that important modern industry, artificial silk manufacture.

Nobel also took an active interest in electro-chemistry, and played his part in the establishment of that industry in Sweden. He became engaged in it through the following circumstances: Rudolph Lilljequist, a Swedish civil engineer, had, on his return from a long stay in England and France, where he was engaged on professional work, carried out experiments at the Polytechnical Institute in Stockholm for the production of caustic soda and chlorine from common salt, on the lines of Castner's method, and was planning to build a factory at Bengtsfors in Dalsland. He

found great difficulty, however, in raising the necessary capital of 300,000 kronen; and for this reason he applied to Alfred Nobel, who was staying at San Remo, in February, 1895, explaining his scheme in a letter. The reply was favourable, and they met at Stockholm in the summer of that year, when Nobel considered the Bengtsfors scheme in detail, and decided to join in forming the company, and to subscribe 100,000 kronen. He was no doubt influenced by his personal confidence in Lilljequist, to which he was to give further expression later, when he appointed him as an executor of his will.

Alfred Nobel intended himself also to carry out electro-chemical experiments at Björkborn. He was particularly interested in the production of metallic sodium by electrolysis, for which purpose special apparatus of a new design was procured. These experiments too, however, were interrupted by his death.

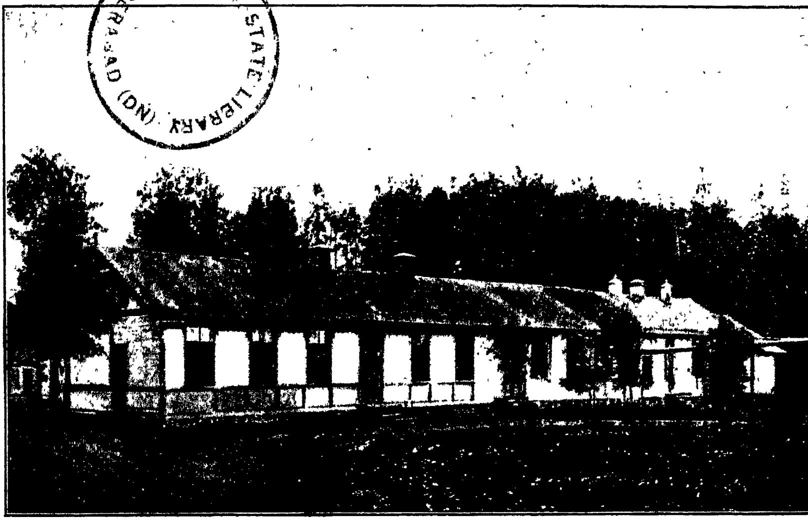
In the latter years of his life especially, when he was endeavouring to free himself from administrative and commercial activities in order to be able to devote his undivided energies to his main interest of experiment and research, Alfred Nobel gave his financial support in numerous instances to the working out of discoveries, in which his personal interest as inventor was inconsiderable or non-existent. We have already mentioned some examples of this, and amongst the inventors whose work Nobel assisted financially were the brothers Birger, and Frederik Ljungström (later known as constructors of steam-turbines, etc.). In 1895 they invented the first bicycle with variable gear, the so-called Svea-velocipede; Nobel interested himself in the exploitation of this invention in England, and invested £40,000 in the New Cycle Company, formed for that purpose. This company, however, was not successful, and was compelled to go into liquidation after some time. Nobel also advanced the money required for constructing a boiler designed by Frederik Ljungström. He bore the expense

of the experiments which the engineer C. Schmidt, of Paris, was carrying out with certain silencing devices, the object of which was to eliminate irrelevant noises in phonographs, Nobel having himself prompted the original idea.

As has already been mentioned, Nobel took a keen interest in biological and physiological problems, although he was a pure amateur in this field. This interest, which had led him to devote part of his maternal inheritance to the furtherance of medical research, also roused in him the desire to engage personally in such experiments. This brought him into touch with J. E. Johannsson, who was then a laboratory student, and is now a professor, and who writes as follows regarding his collaboration with Nobel:

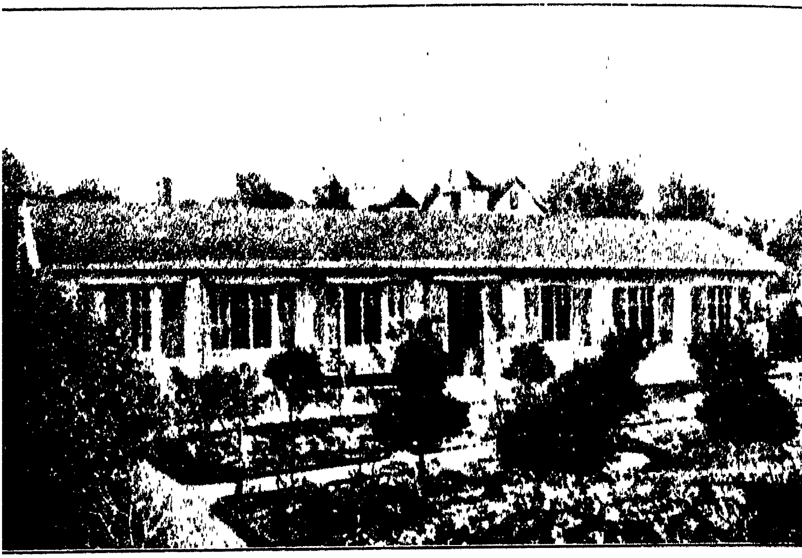
" My acquaintance with Alfred Nobel was due to a wish which he expressed to one of the lecturers at the Karolinska Institute, to meet a Swedish physiologist with a view to discussing the scheme for a series of investigations. I was travelling in connection with my studies when I received this news, together with the request to get into touch with Nobel as quickly as possible, a request with which I immediately complied. Early in October, 1890, I went to Paris, where I stayed for five months.

" In the conversations which I had with Nobel at this time, I found him keenly interested in medical experimental research. He himself developed ideas and suggestions which were directed towards ascertaining by means of experiment the nature of the physical processes connected with disease, and above all, towards discovering by the experimental method means for curing diseases. At his instigation I carried out a series of experiments in blood transfusion in his laboratory in Sévran, as he was especially interested in that question. He frequently stated that he was considering the possibility of founding an institute himself for experimental medical research. He often indicated that he thought that medical theory might be a hindrance and that a person who



ALFRED NOBEL'S LABORATORY AT BJÖRKBORN

ALBERT NOBEL'S LABORATORY AT SEVRAN



THE LABORATORY IN SAN REMO: EXTERIOR

THE LABORATORY IN SAN REMO: INTERIOR

was free from such theory would more readily get at the root of a problem.

"When we met in later years, Nobel often referred to our earlier conversation, and lamented that his numerous activities prevented him from devoting himself to medical problems which had so much interested him."

Of the many new ideas which Nobel sought to realise in the field of explosives and their application, one more is worthy of mention. He wished to apply to the melting of alumina the high temperature produced by the explosive decomposition of certain aluminium compounds, whereby alumina is formed. It was certainly possible to produce emery by this means—why not, therefore, certain semi-precious and precious stones, such as corundum, rubies, sapphires, etc.? The transformation was effected in a bomb, lined with platinum. Molten alumina was produced, but only in microscopic fragments, or crystalline grains.*

When he was not travelling, Nobel generally spent a considerable portion of the day in his laboratory, taking part in various experiments, or discussing new ideas with his assistants. The accommodation required by his experiments gradually increased. At first his laboratory consisted only of two rooms in his house in the Avenue Malakoff, later on of a separate little building at Sévran, where the experimental possibilities were somewhat less limited, more particularly with regard to explosives; when he moved to San Remo, he had a laboratory built in the grounds of his villa which, in addition to a large laboratory room, with library and weighing machines, contained a machine room, fitted with electric

* Amongst the mixtures with which experiments were carried out were aluminium perchlorate and aluminium, in such proportions that they formed aluminium oxide and aluminium chloride, the strange consequence of the explosion being that the explosion resulted in the formation of substances which were solid at the ordinary temperature. Nevertheless this mixture proved exceedingly unstable and dangerous to handle; while it was drying spontaneous combustion occurred on more than one occasion. G. von Feilitzen, one of Nobel's assistants, who is now Explosives Inspector, was severely burnt in the face owing to one of these explosions.

generators for carrying out experiments in electrolysis, etc. Moreover, the climate at San Remo enabled him to carry out a number of experiments in the open air. The grounds of the Villa Nobel gave on to the Mediterranean, and Nobel had a long iron bridge built out from the shore, from which he conducted shooting experiments out to sea, measuring velocities by means of the chronograph.

When he moved to San Remo, Nobel engaged as his private assistant, in succession to Fehrenbach, who remained in Paris, G. H. Beckett, an Englishman, and in 1893, a young Swedish engineer, R. Sohlman.

The carrying out of experiments in a small village on the Italian Riviera was attended with very considerable difficulties. Industrially, Italy was at that time very little developed. Machines, apparatus and chemicals had generally to be brought in from Germany, and this caused difficulties and loss of time. The resources were exceedingly limited for carrying out even the simplest mechanical work. Nobel's neighbour, who wanted to sell his villa, endeavoured to show that Nobel's laboratory was a danger to the neighbourhood, although this was not at all the case. Nobel, wearied by his complaints, bought the Villa Rossi, with its garden and grounds, and incorporated the estate with that appertaining to the Villa Nobel. The villa, a fairly large one, remained empty for some years, until the year 1896, when Nobel furnished it as a place in which he could entertain his friends. He may have thought of inviting King Oscar, who had visited him at Björkborn in 1895, to stay there while on the Riviera.

There is no doubt that Nobel's main motive in acquiring the shares of the Bofors-Gullspang A.G. in 1894 was to be able to carry out his ideas, more particularly in munitions, but also in other scientific investigations. At first he had intended to buy the old gun factory of Finspong, built as early as the 17th century. But

the workshops there, whose resources and extent were something of a contrast to the magnificent old castle, did not appeal to him. At Bofors the position was reversed, and this accorded better with Nobel's wishes.

Nobel's purchase of Bofors was of the greatest importance in the development of the locality. The former owners had suffered severely from the depression that affected the iron industry at the end of the 'eighties and in the early 'nineties. On Nobel acquiring the shares, two and a half millions of new capital were invested in the undertaking, whereby it was placed on a sound financial basis; the machinery was completely overhauled, and extensions were carried out. Even after Nobel's death the concern continued its progressive development.

The old manor house at Björkborn in which Nobel installed himself was the property of the Bofors Company, being left to Nobel formally as chairman of the Board of Directors. He arranged to spend the summer months there, but for health reasons he preferred to spend his winters at San Remo. The laboratory at Björkborn, the construction of which was completed in 1895, was considerably larger than the one at San Remo; it was possible to carry out experiments there almost on the scale of a factory. Apart from four laboratory rooms and two workshops, it comprised a house and machines for the manufacture of powder, a house for electrolysis experiments, a water gas plant, a large accumulator with special apparatus for various experiments, etc. Several qualified engineers and chemists were engaged as assistants. R. Sohlman, who had come from San Remo, was appointed superintendent, the other assistants being G. von Feilitzen, O. Laquist, E. Sederholm, whose main sphere of operation was to be experiments in electrolysis, O. Ljungström and F. Langlet. In the summer of 1896 G. H. Beckett was also summoned to Björkborn from San Remo—the previous winter Sohlman had similarly been summoned

to San Remo in connection with certain experimental ideas. Nobel's intention undoubtedly was to keep both experimental laboratories running; that in San Remo being destined for the initial, small scale experiments, and the one at Björkborn for trying out the results in a more elaborate way. But all these schemes were suddenly interrupted by the death of Alfred Nobel.

The keen interest with which he followed these experiments up to the end is proved by the last lines in his handwriting, which were found on his desk at San Remo:

"San Remo, the 7th December, 1896, Herr R. Sohlman, Bofors. The samples you have sent are particularly fine. The pure n/c powder seems to me excellent. Unfortunately I am again so poorly that I find it difficult to write these few lines, but as soon as I can I shall return to the matter that interests us.

"Yours ever,

"A. NOBEL."

Anybody reading through Alfred Nobel's patents in a critical spirit will undoubtedly often have occasion to doubt Nobel's scientific judgment. Many of his ideas must seem to the sober scientist and manufacturer pure phantasy; but it must not be forgotten that much of what the scientists of the time regarded with scepticism was nevertheless carried into practice by Nobel, and came to be of the greatest practical importance; and we must also remember that some of his other ideas came to be applied in quite a different direction and in an entirely different field from those which their inventor originally had in mind.

The true inventive genius is as extravagant in the production of ideas as is nature in the production of the seeds of life; usually it is only a few seeds that immediately find the right soil for generation and growth. Some of them consist of chaff, without

any fertile seed, while others perhaps fall "on stony ground" because the time is not ripe. Yet such ideas may retain their vital essence for scores of years, or even for centuries; and when favourable conditions supervene they may begin to sprout like the seed that is blown by the wind upon fruitful soil.

From the historic point of view, scientific development is determined by all the efforts and all the mental work which various inventors have expended upon the solution of any problem, whether their work has in the individual case been immediately fruitful or not. For this reason interest in the history of scientific invention has increased steadily of recent years: for the function of all history is, by revealing the processes of achievement in the past, to indicate the direction and the possibilities of the future.

CHAPTER IX

ALFRED NOBEL AND LITERATURE

ALFRED NOBEL'S real interest was of course scientific research, and his name has gone down to posterity as an inventor and philanthropist. It is therefore probably not so fully realised that the famous chemist and experimenter in explosives was at heart a poet, and that it was perhaps for some time doubtful which path he would choose, that of invention or poetry.

As a boy, Alfred Nobel was exceptionally precocious, and he was almost entirely self-educated. Apart from the children's class at Stockholm he never attended school, and of course he never had a university education. His education with his tutor ended when he was only sixteen, and the two years which he then spent travelling were no doubt principally devoted to scientific studies. It is, however, perfectly obvious that, at the age of eighteen he was already highly educated in the humanities, both in literature and in philosophy, although he owed this education entirely to himself. He was particularly versed in languages, and apart from Russian and Swedish, he had a command of French, English and German as complete as is possible for a foreigner. Dr. Emanuel Nobel has told us how he carried on these studies; he would choose a work by an author of established reputation, such as Voltaire, which he would translate into Swedish from the French, and then retranslate it into French, after which he would compare the final version with the French original; by this method idiomatic turns

of phrase were stamped upon his memory. Such virtuosity cannot be developed with impunity; it has been said that no man can *fully* master more than one language, and Nobel himself perceived this fact. He wrote brilliant and witty letters in five different languages, but he did not feel sufficient confidence in himself in any of these languages to come into the open as an author. That may have been why, after some youthful attempts, he withdrew from poetic endeavours for a long time. Having made his choice, he became involved in intensive scientific and commercial work which required the concentration of all his energies; and when, in his old age, he wished to realise the dream of his youth, it was too late. His imagination had not the strength of earlier days, and he lacked the finish which can generally be acquired by continuous literary endeavour. Just as he was engaged upon the one work that he meant to publish, death took the pen from his hand; but even if he never became a poet by profession, he always retained an attitude towards life which was that of a poet, and no presentment of him would be complete that did not take this side of his nature into account

Percy Bysshe Shelley was the poet who most influenced him and it is clear that he had made the acquaintance of his poetry as a boy. There was a strong bond of sympathy between him and the English poet, and Nobel readily adopted Shelley's attitude to life as well as his extravagant idealism, his all-embracing love of mankind, his pacifism, his radicalism and his somewhat chaotic and fanatical "atheism," which was actually not very foreign to Christianity and Platonism. We find traces of all these influences in Nobel, although in his case, by reason of his more practical mind and scientific training they found an expression which was less chaotic and more related to reality.

The earliest poem by Nobel that has come down to us is indeed written in Shelley's mother tongue. It has no title; it begins

with the words, " You say I am a riddle," and according to Nobel it was written as early as 1851, when the author was but eighteen years old. The poem is composed in the form of a poetic epistle, and furnishes unmistakable evidence of a literary talent which in other circumstances might have been capable of fruitful development. For us its main interest consists in the autobiographical revelations and in the light it throws on Nobel's attitude to life in his early years. The youthful poet plunges straight into a consideration of the great problems of life.

You say I am a riddle—it may be,
For all of us are riddles unexplained.
Begun in pain, in deeper torture ended,
This breathing clay, what business has it here ?
Some petty wants to chain us to the earth.
Some lofty thoughts to lift us to the spheres
And cheat us with that semblance of a soul,
To dream of immortality, till Time
O'er empty visions draws the closing veil
And a new life sets in—the life of worms,
Those hungry plunderers of the human breast.
For this Hope dwindles as we fathom Truth.
Forgotten to forget—and is that all ?
To-day a mind with power to act and feel,
A mirror of the universe, wherein
Creation's centred rays combine to form
A focus of intelligence ; to-day
A heart so deeply loving that it seems
As if that band uniting soul to soul,
Were but religion in a brighter form.
To-day all this—to-morrow a cold corpse,
A something worse than clay, which stinks and rots.

Kind hands may strew their flowers, kind eyes may drop
A tear of pity o'er the buried dust,
But, after all, what matters love of theirs,
When all of us that was, is at an end ?

As far as this goes we are all riddles. Nobel, however, next deals with his own life. Most people look back on their childhood as a time that they wish to have again ; his childhood, however, had not been a happy one.

My cradle looked a death-bed, and for years
A mother watched with ever anxious care,
Though little change, to save the flickering light.
I scarce could muster strength to drain the breast,
And then convulsions followed, till I gasped
Upon the brink of nothingness—my frame
A school for agony with death for goal.
Thus passed some years, while life, with death contending,
Hung over chaos on a single thread ;
But spun by destiny such threads will hold,
Till man is brought to tear them with a curse.
Not that to me life seems an idle burden :
I look upon it as a noble gift,
A gem from Nature's hand for man to polish
Till sparkling beams repay him for his toil.

After further digression on existence in general, he reverts to the personal note.

Now to my theme ! We left the infant whining,
A paltry thing, conscious of nought but woe.
We find him now a boy. His weakness still
Makes him a stranger in the little world,

Wherein he moves. When fellow-boys are playing,
He joins them not, a pensive looker-on;
And thus debarred the pleasures of his age,
His mind keeps brooding over those to come.
With an imagination made to scale
The utmost heights to which the mind can soar,
I had not judgment then to check its flights,
Or trace the drawbacks to its golden dreams.
The past, the present with their conscious woe,
Seemed but a stepping-stone to future bliss.

Again he interrupts the narrative to ponder over the riddle of life, and it is some time before he recovers the biographical note.

Thus confident I left in early youth
A home for distant lands beyond the sea;
But, strange to say, even when the ocean spread
Its grandeur round, it struck me not as new.
My mind has pictured Oceans far more wide.
I came to Paris—that's an Ocean too,
Where passion blows its storms and makes more wrecks
Than the salt brine e'er made. Whoe'er explores
That vast unfathomed store of vice and folly,
Must pay his tribute to its idol Pleasure,
Till he perceives he took her painted face
For the rich charms of Nature's healthy glow;
Then turns disgusted from degrading scenes,
And looks for quiet to refresh his heart.
Alas! When Youth has lost its faith in love,
When we have known the soul and heart to rot,
In women e'er her features' charm is gone,
We learn to scoff at Purity itself.

He gets to know a young girl who, "good and beautiful,"

Looked up to me, to me alone, for love.
No selfish motive drew the link between us,
No parents whispered of a proper match.
Why then loved she ? Because it was her nature,
As fragrance is the nature of the rose.
My life, till then a dreary desert like,
Revived to bliss and hope. I had an aim,
A heavenly aim—to win that lovely girl,
And to be worthy her. . . . .
. . . . I felt

Supremely happy, and we met again,
And oft again till we had grown to be
A heaven to one another ; and I learned
The sweet compassion of her love and sealed
It with a kiss, the chaste and hallowed kiss
Of pure affection, though no eye was there
Save the Almighty's to keep watch o'er us.
This might have ended in the usual manner
And brought the joys and griefs of wedded life ;
But t'was not so ordained ; another bridegroom
Had stronger claims—she's wedded to her grave.

Again he stands alone in life.

Yet when such bands are torn, when man is left
A lonely hermit in the busy world,
To brood o'er griefs for which there is no cure.
'Tis sweet to dream that we may meet again
With those we mourn for. 'Tis a lie at best.

But pleasant lies may mask an ugly truth,
At least to weaker minds; the strong require
A solid ground, whereon to build their hopes.
Mine are but few. My love is with the dead.
Nor was I there to soothe her latest hour,
But came to gaze upon a putrid corpse,
Such as but fools can cherish. At the sight
A shudder seized me, and I turned away
In frenzied anguish, unrelieved by tears.
At length they came, and as they freely flowed
A calm came o'er my spirits. Kneeling down
I raised my eyes towards Heaven and prayed
To the great Father there who gives and takes.
The day went down and through the dead of night
The stars shone lovely, and their rays to me
Seemed as a mystic answer from above.
And so they were; what are those rays which fill
This universe but messages from God?
Could we but read their meaning. As I gazed
My mind elating with the grandeur round,
Felt deeply humbled o'er my petty grief,
And I resolved to shake it off as much
As man has strength to do, and to devote
My life to nobler duties. From that hour
I have not shared the pleasures of the crowd
Nor moved in Beauty's eye compassion's tear,
But I have learned to study Nature's book
And comprehend its pages and extract
From their deep lore solace for my grief.

This poem has the authentic personal note; the theme cannot be regarded as a poetic fiction. Nobel destroyed the other poems

of his youth, but not this one. Several copies of it have been preserved, and he once began to translate it into Swedish. Many years later, in 1868, he was travelling in England and met a cultured English clergyman in Devonshire. In spite of their exceedingly different religious beliefs they became friends, and the old clergyman seems to have developed a real affection for the young radical freethinker, for he wrote him several letters expressive of warm sympathy. This sympathy was reciprocated by Nobel, as is proved by the fact that he allowed the old man to read the youthful poem which we have just quoted. The Reverend Mr. Lesingham Smith sent him a long letter in reply, in which he expressed the hope that Nobel would yet come to perceive the truth of Christianity. He had read the poem with great pleasure, and continued:

"Notwithstanding some passages in it, which you yourself appear now to regret, I rejoice that it formed no part of the hecatomb which you made of your other brilliant compositions. The thoughts are so massive and brilliant, if not always true, that no reader can for a moment complain of dullness, nor miss the jingling sounds of like endings any more than in the Paradise Lost. I have read it not only carefully but critically, as you will see by the annexed remarks. I should have considered it as a marvellous production for an Englishman, but the marvel is increased a hundredfold by the fact of its author being a foreigner. I have industriously hunted out every grammatical error and false idiom, and you will see how small the amount of these is. There are not half a dozen mediocre lines in the whole 425. If you can write such a poem in the English tongue, what could you not do in your own, especially if you bide your time, as Milton did, till advancing years shall have enlarged your experience, shall have softened down asperities of thought, and given you a perfect command over words."

This letter indicates that Nobel consigned his other youthful poems to the flames; but there is another similar poem amongst his papers which, to judge by the handwriting, is attributable to the same period. In tenor, too, it is similar, since here again Nobel meditates upon the riddles of life, upon God and eternity, and just as with Shelley, we find here too, a warm, mystic, religious sense, combined with an apparently anti-religious attitude of mind. This poem, unlike the other, is in rhyme.

The solemn silence of the midnight hour
Unchains the fettered spirit and the power
Of reasoning takes a visionary flight
Beyond the limits of detective sight
Which may deceive us, yet attracts the soul
Even with its wild and daring uncontrol.
'Tis then the mind, which care no more absorbs
In search of God ascends His glowing orbs
Or grapples with mysteries which surround
Creation's works within a narrower bound.

This facility for handling the English language is in strange contrast with the incapacity to write good prose in Swedish, which he revealed in his youth. "Brothers and Sisters," an unfinished novel of a somewhat later period, probably 1862, has been preserved; considered as a novel it is extremely weak, especially in phraseology. This may be partly attributable to the fact that the contemporary Swedish novel was so poor, and he seems to have modelled himself on the Swedish rather than on the English novel. The characterisation is almost childish, while the dialogue is unnatural and stilted. Nobel had no idea of telling a story. His interest is centred exclusively upon the ideas, which he finds the opportunity of discussing here. As in his earlier poems, religious ideas are prominent.

A few extracts will suffice to give an idea of the style and nature of his dialogue:

"You have history on your side, Fräulein Duval," Schakomsky remarked, "but everywhere there must be form, and as men clothe themselves in accordance with the generally accepted fashion, so they should regulate their beliefs also."

"If this is a general rule," said Oswald, "belief in free will should be abolished, and people should be compelled to think in accordance with a set pattern, both in matters of religion and otherwise. I acknowledge myself to be of your school, Fräulein Duval: thought has its natural boundaries drawn by a hand that needs not human control. We are certainly surrounded by an eternal riddle; there are mysteries that we can never solve, but why should we voluntarily extend their boundaries from fear of the clarity of truth? But it is to truth that we owe the most sacred triumphs of civilisation. When we think of the petty tyranny of prejudice, we are inevitably brought to the conclusion that freedom of thought is our sole and true protection against all the iniquities that kings and priests have perpetrated under the protection of ignorance and dogma."

"That is to say," said the poet, "that the Bible is to be openly exposed to criticism and contempt?"

"There is nothing," answered Oswald, "that is not liable to misuse and misunderstanding; "but the more we subject the Bible to criticism, the more will the eternal truths contained in it stand revealed, and the more will the Bible itself be purged of many obsolete ideas and absurdities, which are prejudicial to the profound influence of its better teaching, and are not consonant with our more magnanimous conception of an eternal creative and directive power."

The following is another extract: "You might, however, admit, Herr Oswald, that if some distorted or misunderstood story of the

Old Testament should lead us astray in our conception of God, this is remedied by the loving words of the Redeemer Himself. These, at any rate, must be truly recorded. For no human being could propound a teaching that no one at all has yet succeeded in following out."

"Why not?" said Oswald, "for it is generally far easier to give good precepts to others than to follow them out ourselves. The fact, however, that has probably contributed most to the spread of Christian doctrine, is that the Founder proved, by His own example, that the doctrine of love is not irreconcilable with human nature."

"These veiled words," said the poet, "almost lead one to the conclusion that you deny the divinity of Christ, Herr Oswald?"

"His doctrine is divinely beautiful," answered Oswald, "and even if we suppose that it was propounded by a man, its real value is by no means lessened thereby. On the contrary, to do so raises our conception of the perfection of human nature, as well as of an infinitely higher perfection, such as we are not able to comprehend. It has always been our endeavour to invest God with an intelligible form, but this desire has led us to present to our human imagination an unworthy God—in other words, being unable to raise ourselves to His level, we drag Him down to our own."

"Clever sophists," said Morena, "are the most dangerous men there are, for they rob their fellow men of peace, not only in this, but also in a future world. But you, Herr Oswald, I suppose do not believe in life after death?"

"That is a question, Herr Morena, on which I do not like to argue, for hope is a great and beneficent source of happiness, and in the battle with truth, it is difficult to say who most stands in need of encouragement. Hope seems to me like a veil of nature for hiding the truth; as for me, I feel the belief in eternal peace to be a greater blessing and comfort than that in eternal joy."

Among Nobel's papers there is another unfinished story, called "In Lightest Africa." It reveals the same defects of style as "Brothers and Sisters." It has, however, a certain biographical interest, for as in the unfinished novel which we have just quoted, he developed his religious ideas, so "In Lightest Africa" was intended as a vehicle for Nobel's political opinions. He enjoyed displaying fairly strong radical views in his conversation, and the nihilism so popular in the Russia of his youth had undoubtedly exercised a certain influence upon him. But in his heart Nobel had no confidence in the political understanding of the masses; he was no friend of universal suffrage, and still less of parliamentarism, and would gladly have given the Government dictatorial powers. He expressed his views through a character bearing the appropriate name, Avenir, Avenir being a radical, while the "I" of the story is an extreme reactionary, favouring absolute obedience to hereditary kings.

"Even if they are semi-imbecile or criminals?" Avenir contemptuously asked.

"That they very rarely are," I replied, "for the anointed of the Lord have heavenly gifts which are almost irreconcilable with mental deficiency or criminal tendencies. But since you so sharply criticise, or rather pour scorn upon the holy dignity of kingship, what have you better to put in its place?"

"Your question really puts me in a difficulty," said Avenir, "for I must confess that one is as bad as the other. The three forms of government usual at the present day are all about equally valueless."

"What are these forms of government?" asked my neighbour.

"Absolute monarchy, constitutional monarchy, and republican government," answered Avenir.

"But these are the only forms of government that the world

offers," I exclaimed. "Do you mean to assert that they are all bad?"

"Results prove them to be so," answered Avenir; and in support of his contention Avenir begins with the criticism of hereditary absolutionist monarchy. This criticism was fairly facile; his objections to constitutional monarchy are more interesting.

"It is in the highest degree illogical, for a king without power is a lamentable figure. The whole country adores a person whose functions are more or less those of an automaton. Either, as in most cases, he is a complete nonentity, and then it is not easy to see what purpose he serves, or he has a will of his own and the desire for power, in which case he must necessarily direct his energies to the abolition of a form of government which degrades him almost to the level of an animal. In such a country it is parliament—we may as well call it the talking shop—that governs. Their main business is to talk, and in certain countries to collect bribes. The representatives of the people therefore are mainly recruited from the ranks of lawyers and other such parasites. Properly considered, a real constitutional monarchy is nothing but a republic in disguise, the only distinction being that a hereditary nonentity instead of an elected one is at the helm."

"You also consider the republican form of government to be bad," I remarked.

"Not in theory," said Avenir, "but as actually carried out in practice. Its two great faults consist in the fact that the president has too little power, and that his method of election is an unreasonable one."

"But if you give him more power," I argued, "he becomes an autocrat, so why should you depart from the magnificent principle of a hereditary monarchy, having unlimited power?"

"As between the two," Avenir replied, "there is the important distinction of an examination. The qualifications of a candidate

for the presidency are tested, or at any rate ought to be tested, whereas the only qualification that a baby prince can show is his capacity to cry."

Avenir proceeded to defend the president's autocratic powers, with special reference to the dictatorship of Rome. "There are," he said, "occasions in the history of a people when quick decisions have to be taken, and a firm will is needed to direct affairs. Hampered by a king or a president whose hands are tied, a country will often come to grief. He must therefore be given power, and this can be done with less ill results if we but have the assurance that we have chosen the right person, and if there is some guarantee against the abuse of his power. You know that the only time when the world was governed for nearly a century with resolution and reason, was by virtue of the elective system; I refer to that memorable period which began with Nerva, and ended with Marcus Aurelius. It is true that the rulers themselves determined their successors, but this merely proves that a good choice can be made."

Curiously enough this was not the system which Avenir recommended; he developed another one which was certainly much more complicated.

"I assume," he said, "a country such as France, divided into some fifty provinces or miniature states. Each of these shall be ruled by a government, chosen by the population as a whole, or by the educated part of it. Within their spheres these governments must be invested with as much power as may be delegated to them without danger. They must be most liberally paid, and enjoy all such privileges as are likely to make their position a highly enviable one.

"Thereby gifted and ambitious men will be induced to enter the service of the state, where they will have the opportunity of giving practical proof of their ability. The president shall be elected from amongst these governors, to hold office, for a period

of not less than five, and not more than eight years; for the possibility of being chosen at the next election will be an incentive to the other governors. It shall be the duty of parliament to determine which of the governors has been the best ruler, and he shall be chosen president; but the whole press will have publicly discussed the merits of each candidate in advance, and it is inconceivable that any serious mistake could be made."

On being asked what powers he would give the president, Avenir replied, "Unrestricted powers in war, but in peace his powers would be limited by the right of veto of the governors, if a majority should declare against any decree."

"What then would be the function of parliament?"

"It would have to determine, on the election of a president, which of the governors had proved the most efficient, and had best governed his province."

"You regard it then, as unnecessary to summon the 'talk shop' for any other purposes?"

"Yes, for the governors would be able to exercise their veto also against the budget being overstepped."

"Is universal suffrage to be retained in the election of governors and of the parliament?" somebody asked.

"There would be no great objection to that," said Avenir, "although I am not in general an enthusiast for having everybody interfering with the machinery of the state. To give the same elective rights to uneducated and to educated persons, leads to bribery and all kinds of abuses. It is indisputable that an educated man has more judgment than an uneducated one, and the latter instinctively turns to the former for advice. Why in politics should we depart from what is a natural order of things? I hold that only the educated classes should have the vote. To give it to all is about as sensible as to give a father and child equal rights in the family."

" And what about the poor women," said Emmy. " Aren't they to have a vote ? "

" I consider," answered Avenir, " that they are as much entitled to it as we men."

Developing his scheme, however, Avenir was inclined to restrict the rights of women. He did not regard it as advisable to make women eligible for the presidency or for a governorship. While admitting that a queen could govern as well as a king, he said, " I believe nevertheless that it is better to exclude the rivalry of women in this sphere. It is, so to speak, man's province to command."

When he grew up, Nobel appears to have had neither the time nor the inclination to concern himself with poetry, but he attentively followed both Swedish and foreign literature, and, being an idealist, he strongly disapproved of Zola and the whole realistic school. On the other hand, the sceptical and polished Maupassant was one of his favourite authors. In Paris he lived a quite secluded life, and according to Bertha von Suttner, Madame Adam was almost the only person he visited, her salon being at that time the most brilliant literary salon in Paris. His correspondence however, shews that Victor Hugo also sometimes invited him to his house. He seems to have been most keenly interested in English literature, in which he was widely read, but he kept abreast of Scandinavian literature too. He wrote a letter about Ibsen's Peer Gynt which amounts almost to a critical review, and he was an enthusiastic admirer of Björnson's work, although not of his personality. Amongst the Swedish poets he was attracted especially by Viktor Rydberg, and Selma Lagerlöf. Regarding the latter he wrote :

" Have you met Selma Lagerlöf? Ingeborg has sent me 'Gösta Berling's Saga.' Read it. The book is exceedingly original, and although the action is, by our standards, even more unreasonable than is the course of nature, the style is fascinating, and cannot be

too highly praised." He was also naturally attracted by Rydberg's lofty idealism. When, however, he was approached in connection with a memorial to the great poet, he demurred, in accordance with a principle to which he generally adhered. "As a rule," he wrote, "I prefer to consider the bellies of the living when they are empty rather than to feast the eyes of the departed with memorials; for even if we believe in the soul as an independent personality, it is highly doubtful whether it has eyes. Nevertheless, I shall waive my prejudice and subscribe three hundred crowns. There are writers whose works are a memorial, and they need none other. Such a writer is Rydberg, whose poems express both nobility of spirit and beauty of form."

Shortly before his death he again took up the pen of the writer. As has been related, he had lost the great cordite case in 1895, in circumstances which had aroused public opinion in England. He decided, in his bitterness of heart, to write a satiric comedy in English, with the case as its theme. The title is

The Patent Bacillus
Comedy in Acts

Brown versus Adam and Pluton, servants of the Crown
Miss Lux, Counsel for the Plaintiff
Mr. Right, Solicitor for the Plaintiff
The Attorney General, Counsel for the Defendant
The Solicitor General, Solicitor for the Defendant
before Mr. Justice Haze.

It is unlikely that Nobel was acquainted with the comedies of Aristophanes; but his effort has a stylistic affinity with them, and just as Aristophanes is more or less unintelligible to a person who is unfamiliar with the politics of the Athens of the period of Aristophanes, so Nobel's comedy is entirely unintelligible to anybody not conversant with the facts of the cordite case. Nobel of course,

completely lacked the exuberant good humour of the Aristophanic farces, and he seems to have been aware of this himself, for after writing a few sheets containing numerous erasures and emendations, he put the fragment aside and did not go on with it. Another unfinished drama entitled, " A Victim of Imagination " seems to be attributable to the same period. It is quite trivial, and the characterisation reminds one of the comedies of the 18th century. In the finished scenes we have sketches of a banker, with the significant name of Goldman, and his wife. But Nobel returned to the literary interests he had shewn in his youth, and when he was ill, and could not occupy himself in any other way, he began to write a tragedy, to which he afterwards gave the title, " Nemesis." In March, 1896, he wrote to Bertha von Suttner :

" Not having been able to engage in more serious work during my recent illness, I have written a tragedy. I have just finished it, except for a few touches here and there. The subject of it is the moving story of Beatrice Cenci, but I have treated it quite differently from Shelley. The incest motif is rendered so inoffensive that the most censorious public would scarcely be shocked. But the father's baseness is fully revealed, making the vengeance, savage though it is, perfectly natural, and practically a duty. I am curious to see whether this little piece will be played, and I feel that on the stage it should be quite effective. It is written in prose; I do not like to hear verse spoken—it seems so unnatural."

A few days later he wrote :

" There are four acts. The scabrous element is much modified, for old Cenci begins by telling Beatrice that she is not his daughter, supporting his argument by her resemblance to Colonna. I believe that it has great dramatic possibilities, but there are two exceedingly difficult parts, Beatrice and Cenci. The play is written in Swedish ; it is in prose, but in poetic prose. I should have to get it translated into German, as I am not sufficiently

master of that language to translate it myself, and besides I have other things to do. There is one further difficulty; the Austrians would not tolerate the church being presented in such an unfavourable light. I should have to modify, and possibly to cut out some of those passages. But that is really a pity, as I think you will agree."

Although Nobel imagined that his play had been written entirely independently of Shelley's great tragedy, "The Cenci," he was undoubtedly influenced by the English poet. Shelley had read a large number of the documents in the case against the Cenci family, and the material had appealed to him in many ways. His drama gives a perverted account of what actually happened, and it is only recently that Ilario Rinieri and Berto Lotti have discovered the true facts of the case. Not only the father, but the whole Cenci family were depraved, and the indulgence which posterity has shewn to Beatrice is wholly unjustified by the facts. In point of fact, she was not a "pure virgin," but had a child by the steward, Olimpio, who murdered Francesco Cenci; that the father violated his daughter, the central theme in Shelley's drama, is quite unhistorical, or at least not proved. The allegation was made in the course of the trial by Beatrice's counsel in order to excuse her crime and to modify the penalty. But it was not proved. It is possible, but by no means certain, that the severe sentence of death with confiscation of the estate was due to Papal nepotism in order to secure the extensive possessions of the Cenci for the Aldobrandini family. Shelley made this the leading motif, and he presented Beatrice's execution as a judicial murder, attributable to the greed of the Pope's family. Beatrice supplied the foil that he needed for his deceitful, greedy and cunning priests. But Shelley detested not merely all dogmatic religion, but all forms of social organisation, and his whole poetry was a campaign against antiquated beliefs. Society is unable either to protect Beatrice or to

punish the wrong; Beatrice is therefore completely justified in taking the law into her own hands. Such is the argument in Shelley's drama, and the same point of view is expressed in Nobel's tragedy. Beatrice believes that she is entitled to kill her father: "For lesser crimes than his, the State pronounces the death penalty. If the State will not see justice done, the oppressed must take the law into their own hands . . . I am the avenger of outraged innocence and of flouted justice. I am also the instrument of Almighty God, for I carry out His high command."

The philosophy of life which is the background of the drama is the same as Shelley's, and Nobel's interest in expressing this philosophy often leads him to interrupt the action in order to discuss the great problems involved. His attitude towards these problems is on the whole identical with Shelley's. He is an extravagant idealist, but, for that very reason, he is a keen opponent of dogmatic Christianity, although at the same time betraying his passionate admiration for the actual teachings of Christ. He shares Shelley's propensity for converting the principle of good into the principle of evil, and vice versa. The Satan of Nobel's drama is in essence merely a variation of the type invented by Shelley and Byron, a spirit of freedom who has become indignant at oppression. The same unreasoning hatred of "priestcraft" which runs like a red thread through Shelley's poetry is also evident in Nobel's work. "Priestcraft," says Guerra, the enlightened philosopher of the drama, "leads to the worst abuses. It is true that royal power is also seriously abused, and the whole of so-called Christendom still resembles a slaughter house, but in comparison with the terrors of priestcraft, these are but trivialities. The fact is that princes can rely upon their military resources, while the Church has no other support but superstition, which is nourished by ignorance and fear, and whose continuance is secured by the doctrine of hell and by the inquisition." In another passage he says: "Christ preached the

rights of mankind and universal brotherhood; his ministers and their hypocritical following practice every kind of torture and baseness that the human animal can devise." Is there then no hope for humanity. "Yes," answers the philosopher, "a ray of light pierces the terrible darkness of Europe; a more humane outlook is beginning to prevail in all classes. The magic glow of a world that is past illuminates our thought to-day; and we may take pride in the fact that our country raised the standard of civilisation. It was our Columbus, our Galileo, our Leonardo, our Bruno, our Campanella, our philosophers, poets and artists, that first directed men to nobler ends than to burn their fellows and rot their intellects."

The train of thought is not appreciably different from that which we associate with Shelley. This does not necessarily imply that the ideas are borrowed, for they are absolutely in accord with Nobel's attitude to life, as constantly expressed in his letters. On the other hand, Nobel's attitude to life was formed in his youth under the influence of Shelley's writings. Inconsequent irrelevancies, when expressed through the medium of Shelley's wonderful lyric poetry, do not affect one as harshly as in prose, and it was natural that Shelley's opinions should exercise a profound influence upon a youthful mind. It was no less natural that they should maintain that influence upon the man who, in spite of his scientific work and his varied and extensive activities, was fundamentally something of a dreamer, with a firm religious belief in the ideals and principles which he had adopted in his youth.

The dramatic presentation of Nobel's ideas is also derived from Shelley. Both shew us the father, Francesco Cenci, as a devil in human form, but in the case of Nobel, the purely physical oppression produced is more marked, something like the effect of a mediæval torture chamber. As we have seen, Nobel strangely enough thought that he had mitigated the horror of Shelley's drama. In

reality he exaggerated it; the last act, in which Beatrice murders Francesco Cenci, not outright, but with the most horrible tortures, is unutterably painful and unnatural. Shelley's story was to have been improved upon, by making Francesco state at the beginning that he was not Beatrice's father, and this was to make the situation where he violates her after having given her a love potion, less horrible than in Shelley's version. The effect, however, is to make Francesco not better but more revolting. The fact that it is not her father, but a vile wretch, entirely unrelated to her, that Beatrice murdered, may in theory constitute an alleviation of the horror; but the positively devilish tortures to which she subjects her victim leave an impression even more unpleasant than Shelley's drama. The most important variation is in the conclusion. Shelley devotes his last act to the trial of the parricide Beatrice, and the judgment; this act is undoubtedly the finest thing in the play, although it is psychologically the weakest. Beatrice, whom Shelley has presented with right entirely on her side, maintains her magical personal ascendancy, but she obstinately denies the crime instead of confessing to the deed, and without any qualms of conscience, she allows a poor wretch to be tortured to death in order to save herself. Nobel's play contains no such act; it finishes with Francesco's death. He can scarcely have meant to imply that the murder could be regarded as the triumph of supreme divine justice, for Beatrice is no longer competent to act as its representative. It is true that in the opening scenes she is portrayed as a pure-souled martyr, but in the last act the martyr is converted into a fury who gluts herself on cruelty. Nobel's conclusion, therefore, is much more painful than Shelley's. It is true that Francesco is punished, but what about Beatrice? Were it not that history has revealed to us her end, we might imagine that the murder had gone unpunished.

Neither Shelley nor Nobel were able to draw character; they

were not realists, studying men, but idealists constructing types. Their characters are exaggerated and unreal, either devils or angels, but Shelley, who was certainly no dramatist, was a great lyric poet, and therefore had the power to give his creations some semblance of reality. Nobel lacked this power, so that we get the perfectly bald effect of an intellectual and abstract portrayal of character. Moreover, he was not master of his medium; one cannot at the age of sixty-three embark with impunity upon the writing of drama, especially in a language which one has not previously used for literary purposes. The dialogue in "Nemesis" is stiff and artificial, far removed from the "poetic prose" that Nobel imagined it to be. It would appear that the Swedish authoress, Lea, with whom he was on fairly intimate terms (she was his nephew's mother-in-law), wanted to make certain emendations, but Nobel would not consent to this. "The fact that my spelling is poor," he wrote, "is due to my long residence abroad. But when I remember that Lamartine, who knew no language but French, had to submit his spelling to correction, my sense of shame is considerably lessened. In the hurried letter I wrote from London I cannot have conveyed what I meant. What I wanted to say was that in literary matters I do not want collaborators, and prefer to flutter with my own wings rather than to fly with those of others. An author should not allow a single word of his to be altered by another; but he should always welcome criticism, the more severe the better. You have been too gentle with me. I should be quite glad to use Swedish words instead of some foreign words; for instance, daydream. The English snap up any foreign words for which they have no equivalent in their own language. In my view, any word is permissable which can be properly understood, and which clearly expresses what one thinks. But I am a revolutionary in language, no less than in thought. At the end of the seventeenth century they would have had supreme

satisfaction in sending me to the stake. It is not half as hot with the devil as they say. I shall have my little play hectographed or printed in Christiana. I don't want to have anything to do with the Swedish censorship ; it is very kind, of course, but I have been so spoilt."

His drama was in fact printed in Paris, not in Christiana ; but just as it was ready for publication he died, and his friends, who rightly held that a poor drama does no credit to the memory of a great man, had the edition destroyed, except for three copies.

There is no doubt that this single work from his pen would have given the general public a false impression of Nobel. For Alfred Nobel was a true poet ; he had a poet's attitude to life, and in his youth he was able to give expression to it in poetic form ; with the passage of years he lost this faculty. As we have seen, he jokingly describes himself in one of his letters as " a super-idealist, a kind of untalented Rydberg," and there is a certain truth in this characterisation. Up to the last moment, he constantly brooded over the ultimate questions of life, which in spite of his scientific training, he viewed with the eyes of an idealist. If his imaginative gifts had been allowed to develop they would have found their highest expression in reflective poetry.

CHAPTER X

NOBEL AND THE PEACE MOVEMENT

BERTHA VON SUTTNER'S Memoirs convey the impression that it was she principally who had aroused Nobel's interest in peace movements. This must certainly be a great exaggeration. Nobel's enthusiasm for an everlasting peace between the peoples was a feature of his earliest youth. After all Shelley was the writer who made the deepest impression upon him, and it would be difficult to find a more uncompromising pacifist than the author of "The Revolt of Islam." Shelley's pacifism furnished the basis of Nobel's interest in peace, although in the case of the man of science this pacifism lost the fantastically Utopian element characteristic of Shelley, and was concentrated rather upon aims that were practically realisable. It undoubtedly seems inconsistent that a man who devoted so much energy to war-like inventions should at the same time have been a pronounced pacifist. Yet this inconsistency is capable of explanation. First we must remember that Nobel's first great invention, dynamite, was not intended for military purposes, but was essentially meant to be a scientific aid in industrial undertakings such as quarries, etc. It was not until the middle 'eighties that Nobel directed his inventive activities to military problems such as smokeless powder, etc. What attracted him was undoubtedly the problem itself which had a great attraction for him as an inventor from the purely scientific point of view, quite apart from its practical application and its commercial value. When as in the case of ballistite he achieved successes which

were also of the greatest importance to him and to his company, he had enough financial sense to take advantage of them. On the other hand he could not but be sensitive to the incongruousness of his work with the pacific sentiments to which he had been attracted since his youth. He endeavoured to soothe his conscience with the theory that the progress of science would make war impossible. Subsequent developments in the practical use of poison gas, aerial warfare, etc., seem indeed to a certain extent to have justified him in his view, although this line of argument never entirely convinced him, and when about 1887 he turned his inventive energies to military purposes, his pacifism became more pronounced. He now endeavoured to achieve his aim by other means.

He had made Bertha von Suttner's acquaintance in 1876, having advertised for a private secretary. She had answered the advertisement and been engaged, but as she married shortly afterwards she never actually took up the post. They met again in the winter of 1887, which Frau von Suttner spent in Paris, but they do not seem to have seen very much of each other, and they did not meet again until 1892, for the third and last time, at the Peace Congress in Berne. A short time before, in 1889, she had published her novel, "Ground Arms," which attracted a good deal of attention, and Nobel had written her a charming and amusing letter which does not however amount to a full endorsement of her ideas. The letter ends: "It is not for you to cry 'ground arms' since you use arms yourself—the charm of your style and the greatness of your ideas; these have a far longer range than the Lébels, the Nordenfelts, the de Banges, and all the other infernal implements."

In September, 1891, Bertha von Suttner had published an eloquent appeal against war and armaments in the Neue Freie Presse, and she received another appreciatory letter from Nobel who this time wrote in English: "Delighted I am to see that your eloquent pleading against the horror of horrors, war, has found its way into

the French press. But I fear that out of French readers ninety-nine in a hundred are chauvinistically mad. The Government here is almost in their senses ; the people on the contrary getting success and vanity drunk. A pleasant kind of intoxication, much less deleterious—unless it leads to war—than spirits of wine or morphium ! And your pen ? Whither is it wandering now ? After writing with the blood of the martyrs of war will it show us the prospect of a future fairy-land or the less utopian picture of the thinkers' commonwealth ? My sympathies are in that direction, but my thoughts are mostly wandering towards another commonwealth, where silenced souls are misery-proof."

This letter can be taken in two ways ; in any case it does not suggest a devoted disciple who has just had his eyes opened to the blessings of peace. When we look at this letter in the light of Frau von Suttner's discursive article we can scarcely avoid feeling that there is a note of irony running through Nobel's letter and tempering his sympathy.

In a letter written in October, 1891, he embarks upon a more businesslike criticism of the programme of Bertha von Suttner and other friends of peace. It appears that she asked him for financial support for peace propaganda. Nobel sent £80 but added :

" It is not money, I fear, but a programme that is needed. Resolutions alone will not ensure peace ; and the same may be said of banquets and long speeches. What is wanted is to present to well intentioned governments some acceptable proposal. To ask for disarmament is practically to make oneself ridiculous without doing anybody any good, while to ask for the immediate setting up of a court of arbitration is to arouse innumerable prejudices and invite the obstruction of all ambitious persons. In order to have any prospect of success it is essential to begin in a more modest way, and to adopt the practice of England in matters of doubtful legislation. In such cases that country introduces an act with a

provisional validity of two years, or even of one year only. I believe that there would not be many governments that would refuse to entertain such a modest proposal, provided that it enjoyed the support of eminent statesmen. Would it for instance be too much to ask that the European governments should undertake for the period of one year to submit to a tribunal set up for the purpose all differences arising between them, or if they were not prepared to do this that they should postpone any hostile action until the expiration of the period stipulated. This might not seem to amount to much, but it is just by being content with little that great things are achieved. A year is a short time in the life of a nation, and the most aggressive minister would feel that it was not worth his while to tear up a convention that was so soon to expire. On its expiration all states would be eager to renew for one year their pact of peace. Thus without any disturbance, and almost without being aware of the fact, a long period of peace would be secured; then and then only would it be practicable to consider the process of gradual disarmament such as is desired by all reasonable men, and almost all governments. Supposing that a dispute were to break out between two governments, do you not think that nine times out of ten passions would subside during the compulsory armistice before the outbreak of hostilities."

In August, 1892, the Peace Congress met at Berne, and Bertha von Suttner was one of the leading persons attending it. Nobel was at Zürich, and Frau von Suttner wrote urging him to come to the Congress. She received no reply to her letter. He did indeed visit Berne while the Congress was sitting, but only for a few hours and he took no part in the Congress. When Frau von Suttner visited him afterwards at Zurich he said to her: "My factories may end war sooner than your Congresses. The day when two army corps will be able to destroy each other in one second, all civilised nations will recoil from war in horror and disband their armies."

Nobel seems, however, to have been influenced by this Congress in his decision to embark on peace propaganda on his own account; and the story of how this came about is characteristic of Nobel, and of his readiness to help people. Aristarchi Bey, a retired Turkish diplomat, was living in Paris at the time. He had been Turkish Ambassador in Washington, but for some reason or other had fallen out of favour and been retired on a pension of 10,000 francs. It seems that in his distress he appealed to Due who was at that time the minister representing Norway and Sweden in Paris, and also to Reuterskiold, a Swedish minister in Petersburg whom he had presumably known in Washington and Constantinople, where the latter had served, as well as to Lewenhaupt, the Swedish Minister for Foreign Affairs. They all appealed to Nobel and he promised them that if it were possible he would find a post for the Turk in one of the numerous concerns in which he was engaged. A suitable position did not fall vacant, but Nobel took him into his personal service and wrote to His Excellency Lewenhaupt: "It is difficult to say how far I may succeed in finding a suitable sphere for the regular employment of Monsieur Aristarchi's talents; but I have made him an offer which I think he will find satisfactory in that I have undertaken to bind myself for a year, leaving him perfectly free. Should he receive another offer which he regards as satisfactory he will be perfectly free to accept it, whereas my obligation, unless he liberates me himself, is to remain in force for one year. For that year I have offered him 15,000 francs, which he has naturally accepted on such accommodating terms. Monsieur Aristarchi has had much practice in the English and French languages, and also in the skilful diplomatic use of language both in conversation and in writing. Unfortunately a large proportion of my work is of a scientific nature, and in this Monsieur Aristarchi cannot render any assistance. Moreover he knows neither German, Swedish nor Russian, which

languages I often have occasion to use. But one must ignore minor difficulties." This letter, the rough draft of which is amongst Nobel's papers, appears to have been written in October, 1892.

In July, 1892 Nobel had promised Aristarchi Bey to help him if possible, and at the end of August the Peace Congress at Berne reminded him of the difficulties of the Turkish diplomat. He telegraphed to ask whether Aristarchi Bey were still free, saying: "In that case I might have a suggestion to make which would suit you." On Aristarchi replying that he was available, he received from Nobel a letter dated 5th September which is highly illuminating with regard to Nobel's attitude to the Peace question.

"I had occasion," Nobel wrote, "while passing through Berne, to take note of the work of the Peace Congress which was sitting there. I was astonished no less by the rapidly increasing number of able and serious members than by the ridiculous efforts made by gasbags which must spoil the best cause. To demand disarmament or unconditional arbitration is, in the present state of mind of the persons in power, to incur the responsibility of putting forward ridiculous proposals which cannot be of the slightest use to anyone. But all established governments without exception have a common interest in ensuring themselves against such wars as are from time to time incited by adventurers of the Boulanger type, and if it were possible to find some formula which would make it possible to reduce their number it is probable that most governments would subscribe to it fairly whole-heartedly. I have been wondering why the rules governing a duel between individuals should not be applied to a duel between peoples. Seconds would be appointed with the duty of making a preliminary enquiry as to whether sufficiently serious grounds existed to justify a fight. Such a preliminary enquiry would not prevent the two nations from going to war, but who, under such conditions, would be prepared to invite the odium resulting from such action, and to incur the

possibility of provoking a general coalition against themselves. The seconds chosen would naturally be either governments not concerned in the dispute, or tribunals of the character of the House of Lords, or of any other high court. I should be exceedingly happy if I could assist in carrying the work of the Peace Congress forward, even if it were but a step, and in such a cause I should not consider expense. This question cannot be regarded as absolutely utopian; Henry IV's Government was already seriously engaged in endeavouring to solve the problem when unhappily Ravaillac cut their efforts short. Moreover since 1816 there have been 62 cases of arbitration between Governments, a fact which goes to prove that if the nations are still nearly mad the Governments are no more than half mad."

This was somewhat vague as a programme for Aristarchi's work, and there is no suggestion of definite agreements and conditions; the intention being, as we shall see, that Aristarchi should keep Nobel informed of peace efforts in Europe, and should also work the press in support of such efforts and assist them by virtue of his position as an ex-diplomat. Aristarchi replied at length saying that he accepted the proposal with enthusiasm. In two memoranda dealing with it he developed his own views on the question, and declared that he agreed entirely with Nobel that it was essential to work gradually with the aim of setting up a "Haute cour." In October Nobel returned to Paris and they met. Nobel said to Aristarchi what he had already written to Lewenhaupt, namely that the whole arrangement was to be an experiment lasting a year, that Nobel regarded himself as bound for that period, but that Aristarchi was absolutely at liberty to accept another offer if this should come his way. Aristarchi had no objection to offer. He undoubtedly made a very favourable impression on Nobel, and this is substantiated by a letter from Nobel to Lewenhaupt. This was indeed natural, for to judge by his letters Aristarchi was

certainly a man of intelligence, while he had the adaptability of an Oriental, and the diplomat's training in turning out skilful phrases. On their first meeting he ventured to criticise Nobel's peace plans. In his letter Nobel had characterised both disarmament and compulsory arbitration as utopian ideas, and had put forward instead the idea that a certain interval should elapse between the accounts of a dispute and the outbreak of war, which period should be used for negotiations between the two nations concerned. It was however not difficult for Aristarchi to prove that this too was a utopian idea, and he did this so cleverly that Nobel was converted.

On the 15th October Nobel wrote to a Belgian pacifist:

"I am gradually familiarising myself with what has been done; and I have also got an intelligent diplomat to investigate the question. Such specimens exist although they are rare. He has pointed out to me, and this is indeed the crux of the problem, that the reason why the governments are not prepared to admit the principle of undertaking to attempt to settle disputes by arbitration, is because they fear thereby to damage their interests if a pacific solution should ultimately not be achieved. There are governments which believe, rightly or wrongly, that they can mobilise more speedily than others, and they are unwilling to sacrifice the great advantage over the enemy accruing from the extra time gained. This advantage is possibly only imaginary, but the idea is nevertheless too deeply rooted to be easily dislodged. I am beginning to believe that the only true solution would be a convention under which all the governments would bind themselves to defend collectively any country that was attacked. Such a treaty might lead gradually to partial disarmament which is indeed the only kind of disarmament possible, for it is necessary that there should be an armed force to maintain order. In former days governments used to be more narrow-minded and aggressive than their subjects; but nowadays it seems as though the Govern-

ments were endeavouring to tranquillise the idiotic passions of a public that are roused by pernicious papers."

In November he wrote to Bertha von Suttner explaining to her the new scheme which in its basic principles is the same as that on which the League of Nations is based.

"On returning to Paris," he wrote, "I asked a former Ambassador and man of judgment (every rule has its exceptions) to give his opinion on the various plans for compulsory arbitration between nations which have so far been worked out. He put his finger on the spot by pointing out that the decision of an arbitrator might not be accepted, in which case the loss of time would constitute a serious disadvantage to the nation which is able to mobilise most rapidly. This objection is very opposite, and moreover the court of arbitration appointed to investigate the matter would demand a guarantee that its verdict would be carried into effect if necessary by recourse to arms by all the countries not involved in the dispute. That being so we may simplify the stages. Let it be admitted that anything is better than war; the frontiers as they are would therefore be accepted, and a declaration would be made that any aggressor would have to meet a coalition of the whole of Europe. That would not amount to disarmament, and I do not even know that disarmament would be really desirable. A new tyranny, that of the dregs of the population, is looming up, and one fancies that one detects its approaching murmur. But peace guaranteed by the power of collective armies which would impose respect upon any disturbing elements would soon relieve the tension and from year to year we would see the strength of standing armies in the various countries being reduced cautiously but surely as there would be no further reason for maintaining such armies outside of a country inhabited by assassins and their victims."

We see therefore that Nobel did not approve Bertha von Suttner's arbitration scheme. She, however, was not affected by the criticism

of the Turkish diplomat. "In your last letter," she wrote, "you sent me your Turkish friend's opinion in which he doubted the practicability of arbitration courts. These doubts are quite familiar to us 'professionals' of the peace league, and they are answered in the memoranda dealing with the subject." But in spite of the pamphlets which she sent him she failed to convert Nobel to the belief in the possibility of disarmament. He adhered to his opinion that the most effective way of avoiding war was by means of joint military action against any action that broke the peace, and in January, 1893, he wrote a letter to Bertha von Suttner which is certainly remarkable:

"I should like to allot part of my fortune to the formation of a prize fund to be distributed in every period of five years (we may say six times, for if we have failed at the end of thirty years in reforming the present system we shall inevitably revert to barbarism). This prize would be awarded to the man or the woman who had done most to advance the idea of general peace in Europe. I do not refer to disarmament which can be achieved only by very slow degrees. I do not even necessarily refer to compulsory arbitration between the nations; but what I have in view is that we should soon achieve the result—undoubtedly a practical one—that all states should bind themselves absolutely to take action against the first aggressor. Wars will then become impossible, and we should succeed in compelling even the most quarrelsome state either to have recourse to a tribunal, or to remain quiet. If the Triple Alliance instead of comprising three states were to secure the adherence of all, secular peace would be ensured for the world."

"Je voudrais disposer d'une partie de ma fortune pour en faire un prix à distribuer tous les cinq ans (mettons six fois, car si dans trente ans on n'a pas réussi à réformer le système actuel, on retombera fatalement dans la barbarie). Ce prix serait décerné à celui

ou à celle qui aurait fait faire à l'Europe le plus grand pas vers les idées de pacification générale. Je ne vous parle pas de désarmement, qui ne peut se conquérir que très lentement ; je ne vous parler même pas d'un arbitrage obligatoire entre nations. Mais on devrait arriver bientot à ce résultat (et on y peut parvenir), à savoir que tous les Etats s'engagent solidairement à se tourner contre le premier agresseur. Alors les guerres deviendront impossibles. Et l'on arriverait à forcer même l'état le plus querelleur à recourir à un tribunal ou à se tenir tranquille. Si la triple alliance, au lieu de comprendre trois états, ralliait à elle tous les états, la paix des siècles serait assurée."

Such then was the peace programme which Alfred Nobel finally adopted. It may of course be called utopian, but it is at any rate a form of utopianism which Nobel's immediate successor endeavoured to realise in practice, and in the possibility of which Europe's leading politicians believe, or at least pretend they believe, whereas disarmament and compulsory arbitration have not yet emerged from the stage of discussion. Moreover he was by no means convinced that even his programme would be successful in changing the prevailing attitude—if this could not be done within thirty years he was prepared to give up hope.

Presumably he felt that his own strength was not sufficient to carry him through the new task which he had set himself, and it is clear that he was very much disappointed in Aristarchi when he made his closer acquaintance. The latter seems to have regarded the 15,000 francs which he received as a perpetual annuity, and he did nothing whatever to earn the money. He had no influence in diplomatic circles, he did not write a single newspaper article, and the sum total of his efforts seems to have consisted in sending Nobel an occasional peace pamphlet. It is therefore natural that Nobel's enthusiasm for him should wane, and towards the end of the year he informed Aristarchi that he did not intend to renew the contract.

He conveyed his decision to him in a courteous letter dated 18th August, 1893:

"My only reason for not wishing to renew the arrangement is that the almost exclusively technical nature of my occupations and pursuits excludes such active co-operation and display of your great mental gifts as it would, in our mutual interest, be desirable to utilise. I regret it perhaps even more than yourself and I trust that the lapsing of our business connection will in no way interfere with the continuation of our social intercourse, from which I, for my part, have derived much pleasure and great mental benefit."

Nobel had been induced to employ the Turkish diplomat by Lewenhaupt's recommendation, and by his own desire to help Aristarchi in a temporary embarrassment. He had not succeeded in finding a suitable position for him, since Aristarchi had no experience whatever of scientific problems, and he had therefore fallen back upon peace propaganda and written him the letter which we have quoted. On their first meeting Aristarchi had pointed out to Nobel that the great Powers would certainly not accept Nobel's proposal for delaying the outbreak of hostilities by a year, since that Power which could mobilise within a few days would thereby lose its most important advantage, whereas an opponent requiring several months to get ready could arm in the meantime. "I immediately perceived the force of this argument," Nobel writes, "and my further interest in the question was limited to a desire to follow the activities of the Peace Congress. Monsieur Aristarchi's point of view, however, was diametrically opposed to mine, and this I frankly explained to him. He advised me to start a special paper for peace propaganda, to which I replied that I might just as well throw my money out of the window. I now realised that I had no further use for Aristarchi, but as common friends had several times appealed to me on his behalf I did not wish absolutely to disappoint him, and I therefore sought for some

means of making use of his energy and his gifts. I accordingly proposed that he should accept a trial appointment for one year, and I showed him the special consideration of binding myself for this period while leaving him perfectly free. He accepted these conditions and received his 15,000 francs."

Such is Nobel's statement of what occurred, a statement the truth of which Aristarchi had to admit. But it is clear that his dismissal came as a very unpleasant surprise to the Turk. He tried first to appeal to Nobel's magnanimity. He alleged that shortly after receiving Nobel's letter of 5th September, he had received a most attractive offer from the Sultan to re-enter the Diplomatic Service, but that relying upon Nobel's assistance he had refused the offer and in such terms as to preclude the possibility of its ever being repeated. On meeting Nobel some weeks later he had learned to his dismay that it was a question of only a temporary appointment for one year, but he had considerately refrained from showing his disappointment, as he had felt that it would have been a pity to introduce any controversial element at the beginning of his co-operation with Nobel, and he had therefore said nothing about the Sultan's offer. Nobel's final decision had come as a complete shock.

Nobel may be pardoned for having been completely sceptical with regard to Aristarchi's statement. He now realised what kind of person Aristarchi was, and his reply was a cold refusal.

"I have loyally carried out the year's experiment," he wrote, "but I find that you have not carried the question forward one step. I do not know of a single article emanating from your pen that deals with this matter, neither am I aware that you have converted to the cause sponsored by Madame de Suttner a single person of any importance. It is true that you were of opinion that we should proceed by entirely different methods, and that it was essential to found a special organ of publicity. At the very start

you expressed this opinion, and we found ourselves in complete disagreement on that point. If I had had the slightest faith in this method of propaganda I should have gone to Madame de Suttner, who already edits a paper of this kind. But in my opinion any money expended in this way would have been a pure loss. Nowadays parliaments and even governments are much more inclined than are the masses to accept the idea of a Court of Arbitration, and any action in order to be effective ought to be brought to bear on them. It was to this end that I had hoped your efforts would be directed, but your point of view with regard to the problem was so different from the start, that we should have terminated our discussions then and there. Since I knew, however, from our common friends, that your fortunes at the time were at rather a low ebb, I tried to be of service to you by offering some kind of alternative employment. I was careful, however, to state that the arrangement was an experimental one for one year only. Considering how little occasion I have had to make use of your special gifts, I cannot see how you could imagine that such an unusual arrangement should be extended beyond the period originally agreed upon."

The letter closes with the bitter observation:

"If there is one piece of advice that I would give to my friends, it is never to do a good turn. Every time that I have yielded to this lamentable propensity, I have made another enemy. This happens with clockwork regularity. The fault is certainly mine, and I shall endeavour to correct it."

Aristarchi proved obstinate. He suggested to Nobel that their dispute should be submitted to a court of arbitration, and when Nobel not unnaturally refused to entertain this idea he threatened him with an action. This empty menace terminated their correspondence. For Nobel it had constituted a disappointment which he registered with the many others he had already had to

experience; but for us this correspondence is of great interest, because it gave Nobel an opportunity of developing his ideas on the peace question, and for that reason we have thought it better not merely to describe it but to quote it. The letters certainly show that his attitude towards contemporary peace propaganda in general, and Bertha von Suttner's efforts in particular, was exceedingly sceptical.

The unpleasant interlude with Aristarchi by no means damped his enthusiasm in the cause of peace, and during the year before his death, he wrote some letters to Hjalmar Nobel, which give a very good impression of his combination of idealism and his practical sense. He was considering the possibility of acquiring a controlling interest in the "Aftonbladet,"* and he asked his nephew to make discreet enquiries. Hjalmar Nobel imagined that his uncle wished to own a paper for his extensive industrial interests in Sweden; but Alfred Nobel wrote in reply:

"You seem to imagine that my object is to influence the market, but a newspaper owned by me would rather tend to arouse opposition. It is one of my peculiarities that I never consider my private interests. My policy as a newspaper owner would be to use my influence against armaments and such mediæval survivals, but to urge that if they are to be manufactured they should be manufactured at home; for if there is one branch of industry which should not be dependent in any way upon imports from abroad, it is surely the armaments industry. And as there are munition factories in Sweden, it would be no less lamentable than ridiculous not to support them. I simply want to own a newspaper in order to rouse or stimulate it to really liberal views. The leaven is there; this is easily found in a country where the general intelligence of the people is 500 per cent in advance of its constitutional developments."

* A Swedish evening paper.

This letter was written on the 7th December, 1895. Only a few days before, on the 27th November, he had signed the will in which, as is known, he had allotted part of his property to a prize, "for the person who shall have done the most effective work for promoting friendly relations between the peoples, for the abolition or reduction of standing armies, and for the formation and increase of peace congresses." The idea of an enduring peace was therefore the dream that inspired him to the last.

CHAPTER XI

ALFRED NOBEL THE MAN

ALFRED NOBEL was once jokingly described as Europe's richest vagabond. This statement undoubtedly contains an element of truth; while he certainly had several homes, it may also be said that he had none. He was a lonely man who had struck no roots; and he suffered keenly from a melancholy consciousness of the absence of most of those ties by which other men are bound. This is frequently revealed in his letters; he once wrote to his sister-in-law Edla, Ludwig Nobel's wife, as follows:

"What a contrast between us! You live a warm and glowing life, surrounded by loved ones whom you care for and who care for you; you are anchored in contentment. I drift about without rudder or compass, a wreck on the sea of life; I have no memories to cheer me, no pleasant illusions of the future to comfort me, or about myself to satisfy my vanity. I have no family to furnish the only kind of survival that concerns us; no friends for the wholesome development of my affections, or enemies for my malice. Yet I am afflicted with a bent for self-criticism, whereby every blemish is revealed in all its unredeemed ugliness, and the veil is torn from all my deficiencies, leaving them in all their naked poverty. Such a portrait is out of harmony in a home of joy and contentment, its proper place is the wastepaper basket, to which it will be consigned."

His business activities, the numerous factories and companies in which he was interested, forced him to be almost constantly

travelling; if he was "at home" for a time, his "home" was practically nothing but his laboratory, where he would spend the whole day engaged upon new discoveries on which his brain was ceaselessly working. His home was at Krümmel until, in 1873, he purchased a house of his own in the Avenue Malakoff in Paris. After a time, however, the laboratory which he had installed there proved too small, and in 1881 he therefore had a new one built at Sevran, some distance out of Paris. He was, however, practically driven out of Sevran, having wounded the delicate sensibilities of French national feeling, the French taking offence at the fact that Nobel powder was being sold to other countries. In April, 1890, Nobel wrote to his nephew Emanuel:

"At the beginning of March, Barbe and Freycinet began to dispute in parliament. Barbe behaved rather stupidly, and incurred a merited reprimand. But the unfortunate consequence is that the Government has, by virtue of its monopoly, prohibited me from manufacturing even the very smallest amount of explosive, or to possess any kind of weapon for my shooting tests. This is pure chicanery; but as they threaten to put me in a fortress, which would have had the disadvantage of still further spoiling my digestion, I cannot resist or defy the prohibition. The delightful thing is that the War Minister, some days before he prohibited me from manufacturing explosives, himself asked me in writing to make him some samples. Not to be allowed to work at Sevran has pretty well upset my applecart. I was in the middle of some very interesting problems which will have to be put on one side; it is not at all easy to move my laboratory abroad, quite apart from the considerable expense involved." As the French press also began to attack him violently, he turned his back upon that country, and settled at San Remo in Italy, where he built himself a magnificent laboratory and a villa which he called Mio Nido.

In 1894 he acquired an additional home; he bought the works at

Bofors, and furnished the old manor house at Björkborn with a view to spending some of the remainder of his life there. He left the furnishing of this house to his nephew Hjalmar Nobel, and in October, 1894, he wrote to him :

" I should like to add a few remarks.

" 1. As long as I can afford it I shall give my men friends good tobacco, so that a smoking room is really unnecessary.

" 2. It is not permissable for a bachelor to have one ladies' spare room, but he may have several. It might therefore be a good plan to have a few rooms furnished in a way suitable for ladies and gentlemen of modest requirements. Actually, from such investigations as I have made, there is nothing in the construction of the fair, but usually repulsive sex, which would require special furniture. . . . It is generally difficult to achieve harmony in the scheme of decoration, but this one readily excuses in view of the fact that nature herself offends against these rules. Have you ever, except in the case of American women, seen legs and arms that are laterally symmetrical, or have you ever seen a nose that was not crooked ? "

Two years later his life was at an end, and the question then arose: where had he been domiciled, in France, Italy or Sweden ? The problem was solved by deciding that Bofors was his actual domicile. Quite apart from its legal aspect, this decision was in accordance with the truth, from the sentimental point of view. Like a large number of his generation, Alfred Nobel regarded himself as a cosmopolitan, but although he never thought about it, he was fundamentally a good Swede, and however much he might be a citizen of the world, he had struck roots in his native soil, and for that very reason felt himself homeless when abroad. This is undeniably a strange fact, for he had left Sweden at the age of nine, and had only been there on occasional visits since, spending his whole life in foreign countries, in Russia, Germany, France

ALFRED NOBEL IN SAN REMO

ALFRED NOBEL IN 1896

and Italy; but he had always felt strange in them, and his real feeling had always been for Sweden. He followed Swedish literature and Swedish culture generally with sympathy, and when a subscription was raised for a scientific object at home, Nobel was almost always appealed to, and very rarely in vain. To the Swedish colony he was a protector to which it constantly had recourse; he wished to be buried in his native soil, and in spite of the cosmopolitan temper of his will, the Swede in him breaks through, for it was to Sweden that he entrusted the execution of testamentary dispositions, since he had "found the greatest number of honourable men in Sweden, and therefore assumed that his last will would be carried out with greater honesty here in Sweden than elsewhere." This feeling for his country was an extension of that sense of loyalty which was one of the dominant characteristics of Alfred Nobel's nature. He was constant in his friendships, and there have probably been few sons so good as he. Almost every year he travelled to Sweden for his mother's birthday. He never forgot her at Christmas, or any of her relations and friends either, all of whom he dealt with on her behalf. It was mainly due to him that she died a rich woman. Some extracts from her letters give a good idea of the relationship between them; in February, 1884, she wrote to him: "I have again received three thousand kronen through Oberg from my dear good boy. Many many thanks, my beloved Alfred, for all your generous gifts. Through your generosity I am able to make some small contribution to those who have nothing, and would not be able to get the barest necessities; so I have not paid the last amount into the bank."

In October of the same year she wrote to thank him for his visit on her birthday, the 30th September: "I have," she wrote, "recalled to mind all the delightful hours which my dear Alfred has given me by coming to see me. I wish I could shew the gratitude which my old heart feels for my dear, dear son."

At Christmas she wrote: "There is no need for me to describe in words the joy that I felt when I received, first your telegram, and then the dear letter I had so much longed for; for they both came from my dear son, who in his indefatigable goodness never forgets at a festival to add to the joys of the young and the old. Fredrique has already provided Christmas presents for all those who usually get them from their good Uncle Alfred. What you were good enough to give us last summer is ample for this, without my having to draw anything out of my account. If that ever should be necessary there is plenty there for me, all of which I owe to the industrious work of my dear Alfred, who possesses so much and can fulfil all my wishes, except for two things which are not to be had for money—really good health, and to be able to see my dear boy of Paris as often as I like. But I am afraid that if that could be done, you would get tired of the old woman, although I am your oldest friend." In January Nobel received another letter thanking him for all his gifts to "the little old lady." "But," the letter continues, "neither the furniture nor the room is fitting for such priceless objects as my darling has sent me. Relations and friends gaze in admiration at the flowers and the basket, and everyone knows at once from whom they come, for there is only one Alfred Nobel, whose magnificent goodness has been felt by so many; and it is his mother's pride to have such a son."

On the 7th December, 1889, the old lady closed her eyes for ever. She was rich, as we know, this being due principally to her son's care. Nobel wrote to the executor on returning to Paris after the funeral, stating that he did not wish to make any claim upon the estate:

"As I said in Stockholm, I wish to keep for my share only my mother's portrait, and some trifles which she was fond of, and which I especially associate with her. On the other hand, I reserve the right to dispose of the third part which would fall to my

share. I wish to allot a certain sum to a beautiful but unpretentious and unostentatious memorial tablet; another portion I wish to allot to a philanthropic fund to be founded in her name, for which purpose I have an amount of a hundred thousand kronen (£5,500) in view. I have no objection to advancing a considerable proportion of this sum pending the winding up of the estate." With reference to the memorial tablet, he wrote in a later letter that he had not realised that his mother would be buried in a family grave, in which his father and his brother Emil already lay: "Let us have three bas-reliefs—we must certainly include one for Emil—and let us reserve one for the next comer, I refer to my old, worm-eaten self. I suggest this only for the sake of symmetry, for folk such as I are happiest without any portrait, both in the world of light and in the world of shadows. It really seems almost pitiable to wish to be something or somebody in this motley collection of fourteen hundred million two-legged tailless apes, which walk about on this earth projectile as it speeds through space."

When he next wrote he had changed his mind about the bas reliefs, and thought that it was "better to give up the idea for the present, and that for various reasons: for one thing it is difficult to get a good likeness, and for another thing metal medallions are gloomy and ugly, and also you cannot put several medallions over one another without making the grave hideous. I want to divide up all my share in my mother's property, keeping only her Zorn portrait and those things which I sent her from here, that is, the watch, a silver filigree basket, the bracelet with the double portrait, and a large piece of porcelain which bears the monogram A.N., and which is used as a vase. I promised the watch to Betty Nymalm (she had nursed the old lady in her last illness), but I think I am sorry about this, as my mother was so fond of it, and I hope she will let me keep the watch in return for compensation."

The value of Alfred Nobel's third share in his mother's estate

amounted to 280,800 kronen (£15,510). He applied 102,000 kronen to considerable subscriptions to institutions in Sweden, the Karolinska-Institut being granted 50,000 kronen to form a Caroline Andriette Nobel Fund for experimental medical research "in all branches of medical science, and for the furtherance of such research, both for instructional and general purposes." The New Children's Hospital received a donation of fifty thousand kronen, which was also in Andriette Nobel's name, and the Central Gymnastic Institute was given two thousand pounds. He allotted 119,040 kronen to cousins on his mother's side, and other relations, the grave cost 2,800 kronen; he applied 17,183 kronen to philanthropic objects in Sweden, and 15,880 kronen for the benefit of the Swedish colony in Paris. "There thus remains," his letter continued, "a balance of about 24,000 kronen to be divided; but it seems as though the whole of Sweden is going to apply to me, for every day I get a whole stack of letters from my country, with the most unreasonable suggestions for donations. In a letter I got yesterday, a man wrote that he needed only 30,000 kronen to purchase a quarry on which he had had his eye for a long time, and he thought that I ought to present him with this trivial sum."

His mother had been the great love of his life, and he does not seem to have had any other, except possibly the girl indicated in the youthful poem which we have quoted. He was also on affectionate terms with his brothers, although the three had different temperaments, and he would on occasion write pretty sharp letters about them, and still more, to them. But he had a great sense of his duties as a brother, and he therefore energetically assisted the undertakings at Baku and Petersburg, although, as we have seen, his and Ludwig Nobel's business principles differed widely in certain respects. Ludwig aimed, above all, at extending his business to colossal proportions, and did not always sufficiently consider the means available. Alfred

was more cautious, and was reluctant to borrow money, a question on which the conflict of opinion was occasionally somewhat acute. "The main point," wrote Alfred, "and it is the only question on which our views differ, is that you build first, and then look about for the wherewithal, whereas I propose in future first to find the wherewithal, and then to expand. If we eliminate this distinction, I am as much in favour of expansion as you are." But after another conflict of this kind, Alfred wrote to Ludwig: "I was more delighted than you can imagine by your exceedingly friendly letter from Vienna. We are both in the decline of life, and approaching the evening of our days; this is certainly not a time for yielding to trivialities, such as are at the root of most of what is known as strife. You think and feel on too big a scale to be that way inclined, and as for me, I am at peace with all and sundry, except myself. You are the last person with whom I would wish to have any difference, and if there has been any shadow between us, it has long ago been obliterated by the 'Let there be light' of the heart."

This sense of family loyalty was manifested in other ways too. As we have seen, Alfred Nobel was a radical both in religious and in political matters, and there can be no doubt that his attitude of mind had been affected by the Russian milieu in which he had grown up. Like Shelley, he had a certain leaning towards "Bolshevism"; but his radicalism was of a very gentle kind, and he was always afraid of wounding anyone, and in this way, too, he was akin to Shelley. He liked to give expression to his "atheism," and in letters to persons of similar views there are several sarcastic remarks about the beliefs of Christianity, which are not always in the best of taste. He had something of the 18th century dogmatic hatred of priests, but such remarks were in essence a *facon de parler* rather than an indication of real conviction. He was, above all, an extravagant idealist, and as such had a

profound respect for spiritual values. Nobel was very far from giving any practical expression to the views which some of his less considered remarks might seem to imply; he was one of the most liberal supporters of the Swedish Church in Paris, and we have a highly remarkable letter in his own handwriting which he wrote to the Swedish pastor in Paris, in 1885, when asked to help a hard case: "Although I am frequently taken in, I am always glad to be able to help honest and industrious people out of difficulties against which they are struggling in vain. Herr B. thinks that he can manage with 600 francs, but as I know well that insufficient help is practically the same thing as no help at all, I have increased the amount to a thousand francs. If only they are some use to him! Besides, he had a good spokesman, for whom I cherish the greatest regard, although we seldom meet, to my great loss. Our religious views differ possibly more in form than in substance, for we are both agreed that we should treat our neighbour as we would be treated by him. Indeed, I go a step further, for I feel a loathing for myself that I by no means feel for my neighbour. As far as my theoretic religious views are concerned, on the other hand, I admit that they diverge considerably from the regular path. It is just because these questions are so far beyond our range that I refuse to recognise their solution by human reason. In religious matters, to know what one must believe is as impossible as the squaring of the circle; but to distinguish what one *cannot* is by no means beyond the bounds of what is possible. This boundary I do not cross. Any reflective person must realise that we are surrounded by an eternal mystery, and this is the basis of every true religion. What you see through the veil is nothing; what you believe you see is a matter of individual phantasy, and should therefore be confined within the limits of the individual point of view. But I am losing myself in the realms of metaphysics instead of, as was my intention, expressing my gratitude for your

kind letter, and assuring you of my affection and my very special regard."

It was characteristic of Nobel that this confession of faith should have been made in connection with a gift, for to him religion without deeds was no religion. Religion and love of mankind were for him as closely intertwined as was conceivably possible; religion that did not express itself in deeds was revolting to him, and his opinion of Christian ethics was as high as his opinion of Christian dogma was low. "If only you could understand," he wrote in a German letter, "that one can help a human being without any ulterior motive! Amongst the Israelites this suggested itself to only one person, Christ, and so strange was the idea that he was awarded the diploma of divinity."

Nobel was exceedingly generous in helping people, and a vast number of begging letters and letters of thanks are to be found in his correspondence. They are in every conceivable language, Swedish, Norwegian, Russian, German, English, French and Italian; they throw a particularly illuminating light upon the life of the Swedish colony in Paris. They reveal that Nobel did not help with money only, but also with advice, and not least with personal friendship. Particularly touching are certain letters from a poor Swedish girl, who had had a very bad time in Paris, but had in the end obtained a position as an assistant in a chemist's shop. She is not asking Nobel for money, on the contrary, she says that she is managing quite well; she writes to him as to an old uncle, about all her interests, and her views on life. Other Swedes had been harsh and unfriendly to her, but not Nobel.

"If you come this way, to the Rue de Rivoli, Herr Nobel, do say good morning to me. It would give me such pleasure to see you once again." Nobel did come to her chemist's shop, as she had asked him to do; she wrote to him afterwards saying: "I thought that I should never see you again, Herr Nobel, and was so glad

when I saw that it was really you, that I could not think or speak properly. If I could only be of use to you in some way, it would give me such happiness. I would at any rate have the joy of seeing you once again. I must have a very small heart, for there is nobody on earth whom I really care for, except Mamma, little Mark, and you, Herr Nobel." He seems to have repeated his visit, for in another letter she writes: "Many thanks for your friendliness in coming to see me. I thought that there was nobody at all who bothered about me!" Such letters are eloquent.

His generosity naturally became known to cadgers, and he was positively snowed under with requests for help. In a letter of 1892 he wrote: "Not a day passes without the post bringing me at least two dozen such requests for help, averaging about twenty thousand crowns. This amounts to at least seven million crowns a year; enough to demoralise even J. Gould, Vanderbilt and Rothschild. As for me, I have long since come to the conclusion that it would be much preferable to have a reputation for meanness than to have acquired the reputation of being ready to help. It always hurts me when I have to refuse, and this happens so often that it takes up a large proportion of my rather limited time." He seems sometimes to have given really beyond his means. In 1886 he wrote to Alarik Liedbeck, who was undoubtedly his most intimate friend, and from whom he had no secrets: "During the last few years the demands on my purse have been so heavy that I have been driven to adopt an attitude which many may perhaps regard as mean, but which is really simply essential prudence. Although my income is very considerable, I have been forced, in each of the last two years, to supplement it with a million francs taken from my capital. One can go on like this for a time, but not for ever."

A natural consequence of his generosity was that he often found that his gifts had fallen into unworthy hands; in business, too, he

frequently encountered dishonesty, and he soon developed a disillusioned attitude to life, but this did not prevent his trying to relieve want where he could. He was melancholy by nature, and his numerous disappointments had emphasised this tendency, which often finds expression in his letters. Indeed, they almost convey the impression that he was a profound pessimist, lonely, unhappy, and suspicious of his fellow beings, whose society he preferred to avoid. When Robert Nobel once proposed that he should come to Baku, he replied:

"The only inducement to me to go there would be the company I should find there—yours, and possibly Ludwig's; but the waterless, dusty, oilstained wilderness has no attraction for me. I want to live amongst trees and bushes—dumb friends who will not get on my nerves—and when I can, I want to avoid cities and deserts."

His contemporaries say that when he was still quite young, he would suddenly disappear, and remain away for a fortnight at a time, simply in order to be alone. Sometimes his melancholy amounted to real bitterness: "You refer to my *numerous* friends," he once wrote. "Where are they? They are stuck fast in the morass of lost illusions, or in the bogs of moneymaking. I assure you that numerous friends are only to be found among dogs, whom we feed with the flesh of others, and amongst worms whom we feed with our own. A grateful belly and a grateful heart are twins."

But this pessimism was in its essence only another expression of Alfred Nobel's idealistic demands on life; fundamentally he was one of the most complete optimists that has ever lived, an enthusiast who believed it possible that science could make men happy, and that everlasting peace would in the end supersede the barbarity of war. Bertha von Suttner quotes a remark of his in a letter to a friend: "To disseminate enlightenment is to disseminate prosperity—I mean general prosperity and not individual riches,

and with prosperity disappears the greater part of the evil which is our heritage from darker times. The triumphs of scientific research and the ever increasing field which is coming under its sway give us reason to believe that the microbes of the soul and of the body will soon be exterminated, and that the only kind of war which humanity will wage in the future will be the war against these microbes." His will of course also expresses this attitude of optimism. The pessimist easily becomes either a disinterested or a satirical observer of life; he does not himself take part in the worthless efforts of his fellowmen. Alfred Nobel's whole life, on the contrary, was work, and it was through work that he drove out the demon of melancholy. He loved work, both for its own sake, and for the results for humanity. He would forget his meals while at work, and led an exceedingly irregular life, as far as such things were concerned. His life was also remarkable for its wide range, and for all the variety which he contrived to get into it; he contrived however, to divide it up with some practical skill.

"You know," he wrote to Emanuel Nobel, "that I am piling up my work very considerably; not that, as is generally supposed, I am actually doing it myself, for nine-tenths or more of my working hours are occupied with technical matters, with contracts, questions regarding patents and affairs with lawyers, all of them matters which cannot be delegated. With reference to the purely business side, however, it is my rule never to do myself what another could do better, or at any rate, as well. Were I not to make this my rule I should long ago have been worn out in body and soul, and probably ruined as well, for if you try to do everything yourself in a very large concern, the result will be that nothing will be done properly."

As an employer Nobel does seem really to have observed his own principles of regard for the dignity of man and respect for the liberties and opinions of others. Bertha von Suttner relates

in her memoirs the following story of her first meeting with Nobel. Nobel, as has been stated, advertised for a private secretary, and Bertha von Suttner applied for the position. A correspondence developed between them; "His letters," she writes, "were witty and intelligent, but they were melancholy too. He seemed to be unhappy, a misanthropist of wide culture, with a deep philosophic attitude towards life. Although a Swede, whose second mother tongue was Russian, he wrote German, French and English in an equally faultless style. After a few letters had been exchanged, we came to terms, and I was engaged. Alfred Nobel made a very pleasant impression; in his advertisement he had described himself as an 'old gentleman,' and we had thought of him as a grey-haired invalid. But this was not the case; he was then only forty-three years old, of somewhat less than average height, with a dark beard, and features that were neither handsome nor ugly; his expression was somewhat gloomy, but this was softened by his kind blue eyes. His voice had a note that was sometimes melancholy and sometimes satirical. He met me in the hotel where I was staying, and owing to the letters which we had exchanged we did not feel strangers to one another. Our conversation became lively and interesting, and after breakfast in the dining-room we drove in his carriage through the Champs Elysées. Then he showed me his house, and my rooms."

This portrait suggests a cultured man of the world, and no harsh and exacting employer; and we get the same impression from a letter that he wrote to one of his later private secretaries:

"I am a misanthropist, but exceedingly benevolent; I am very cranky, and am a super-idealist, a kind of Rydberg without talent; I can digest philosophy better than I can my food." The letter proceeds to state his requirements. "Apart from Swedish, English is a very important qualification. My requirements are terrible—perfect English, French, German and Swedish, stenography,

competence in the use of the Remington typewriter, etc., etc., but I am not one of those who ask for impossibilities, and if a person is sympathetic to me my list of requirements collapses like a pack of cards. Last year I had engaged a Mr. S. as secretary, but after a week I found that he had more gift and taste for chemistry. Since then he has been employed in my laboratory at Bofors and is one of the few people I am really fond of. This is due to the fact that although I am a kind of worthless thinking machine I do recognise and appreciate the value of others. Avis à la Lectrice."

He did not adopt this kind of attitude only to those who were socially on the same level as himself. His relations with his workmen embodied the same principles. The editor of the Conservative paper *The Working Man's Friend* had asked him to distribute the paper at Bofors, saying : " Agitators are instilling so much poison into the minds of the workers that it is the duty of every employer in his own interests to provide the antidote." Nobel replied : " I should regard it as unreasonable if the workmen at Bofors were to prescribe what I should read and what I should not read ; conversely they have the right to demand that I shall not make any such interference with their liberties." At this time the question also arose of shutting down part of the factory at Bofors, and on the this question he wrote to Hjalmar Nobel : " I have not the necessary data to pronounce a definite opinion as to whether we should carry on or close down ; but in so far as there would be any question of dismissing some of the men, I am of opinion that we must endeavour as long as possible to avoid such a painful measure."

It is said that no strike ever occurred in any of the concerns for which he was responsible.

As we have seen, Alfred Nobel himself was a terrific worker, and one of his letters contains a passage which is a positive hymn to work, while it also reveals his highly developed feeling for nature. The letter is from the Ardeer Factory in Scotland.

" If I had not got my work here, Ardeer would certainly be the most depressing place in the world. Picture to yourself everlasting bleak dunes with no buildings. Only the rabbits find a little nourishment here ; they eat a substance which quite unjustifiably goes by the name of grass, and of which some few traces are to be found here and there. This is a wonderful sand desert, where the wind always blows, and often howls, filling the ears with sand which also drifts about the room like a fine drizzle. There, like a huge village, lies the factory, and most of the buildings have hidden themselves behind sandhills. A few yards away the ocean begins, and between us and America there is nothing but water, a sea whose mighty waves are always raging and foaming. Now you will have some idea of the place where I am living ; as I have said, without work it would be intolerable. But work beautifies everything, and thought creates a new life in which we can dispense with luxury and comfort without missing them, and in which we are never forced to feel the leaden oppression of boredom."

The work that really interested him was scientific work, and as early as 1885 he wrote to a member of his staff :

" When the improvements on which I am now working have been carried out, I intend to retire from everything to do with business and to live like an old maid, on the interest on my bonds. I am therefore gradually selling out my various holdings in dynamite and other undertakings. In saying that I intend to live like an old spinster on my bonds, I should add that I do not mean to sit and twiddle my thumbs, but that I intend to devote myself to science to the exclusion of business."

It is, however, no easy matter to wind up businesses involving millions, and it may be questionable whether he ever considered doing so more seriously. In 1893 he had an honorary doctorate conferred upon him in Upsala, and although, as we shall soon see, he was exceedingly indifferent to distinctions, he confessed that he

appreciated this, and his membership of the Academy of Science. He seems moreover, after that event, to have considered again the possibility of devoting his life exclusively to research, for about this time he wrote to Alarik Liedbeck: "It would be almost a pity if I were to kick the bucket now, because I have some particularly interesting things in hand. But since the creatures have made me a Doctor of Philosophy, I have become almost more of a philosopher than before, and I hold that the word 'utility' represents an illusion."

He loved work, and—when the spirits of Niflheim came—loneliness. Ordinary society life, dinners, receptions and so on, he loathed. On the other hand, when his work permitted, he was glad to seek the society of intelligent people, preferably such as had a broad point of view, and it is a mistake to suppose that he was merely a worker, and a boor in company. He had indeed all the qualities that would have enabled him to become a real *charmeur*. As his letters may have indicated, he had a natural and unforced humour; he had a wide culture, not only of a scientific, but also of a literary and philosophic order. He spoke five languages like a native, and his letters are such as few Swedes could have written. When he had the time available, he enjoyed the society of cultured and intelligent women. He kept up a correspondence with quite a number of such ladies, and he had an enviable faculty for paying them pretty compliments. At the same time, he was a severe critic. In one letter he wrote: "I personally find that the conversation of Paris women is the most dreary that I know, whereas to meet cultured and not excessively emancipated Russian women is delightful. Unfortunately they have an aversion from soap, but one must not ask too much."

With regard to the importance of social life, he wrote: "It is unfortunately the case in life that he who withdraws himself from all cultured society, and neglects to keep alive the interchange of

ideas with thoughtful persons, finally loses the capacity to do so, and sacrifices both in his own estimation and in that of others, the regard which he had won." For this reason Alfred Nobel never allowed himself to become a dry scientific worker. He had a rich and generous personality and an understanding instinct for all that was human.

On the other hand, there have been few persons that have so little desire to exploit themselves, and he had an aversion from any kind of advertisement which was obviously sincere, and was sometimes directed against quite innocent objectives. When an editor asked him for his photograph for his review, he emphatically refused, saying: "In these times of elaborate and shameless advertising, only those persons who are specially qualified for it should allow their photographs to appear in a paper;" when a Swedish publisher, who wanted to bring out an illustrated book on famous Swedes, approached him, Nobel replied: "It is a pleasure to me to subscribe to this valuable and interesting work; but I would ask that my picture be left out of the collection. I am not aware that I have deserved fame, and I take no pleasure in its clatter."

It was natural that with such prepossessions he should be exceedingly critical of anniversaries, memorials and such things. "My natural inclination," he wrote, "is less to honour the dead, who feel nothing, and who must be indifferent to marble monuments, than to help the living who are in want." He expressed his views most explicitly on the occasion of a proposed memorial to Pasteur.

"I am convinced," he wrote, "that Pasteur himself would like to send all such manifestations to the devil, and that he loathes any advertising of his name because it tires him out to deal with the callers that result. Like all notable persons living here, he really has peace from that worst of all plagues, reporters. Bugs

are a positive delight compared to them, and it would be a real blessing if an exterminating powder could be invented to deal with this two-legged pest. I believe that Pasteur suffers much from the attentions of reporters, and has been so much exhausted by them that he would gladly dispense with academic honours. A fund bearing his name would certainly be more to his liking than a medal. He has all he wants in the way of decoration for front and rear."

Nobel himself had only a few orders. He gives a very amusing account of the various occasions which led to his being decorated.

"I have received no order at all for my scientific work; my orders have no explosive basis. I owe my Swedish order of the North Star to my cook, whose skill won the approval of an eminent stomach. My French order was conferred upon me as the result of a close personal acquaintance with a minister, my Brazilian Order of the Rose, because I happened to be presented to Dom Pedro, and finally, the famous Order of Bolivar, because Max Philippe had seen 'Niniche,' and wished to give a demonstration of the manner in which orders are conferred. As for medals, I possess a gold medal presented by the Swedish Academy of Science. I am also a member of this academy, and set more store by this distinction than by the various orders, even not excluding the Order of Bolivar!"

His distaste for all outward show went so far that he refused to sit for his portrait. The portrait in the possession of the Nobel Foundation is a posthumous work; when his nephew, Dr. Emanuel Nobel, tried to persuade him to sit to the Russian painter Makoffsky he replied, "I have met Makoffsky, and I give my word that as soon as God the Father in His benevolence makes my carcase thirty years younger, so that it is worth oil and canvas, I shall sit to Makoffsky like a good child, and present posterity with a futile

representation of my interesting, beautiful and remarkable hogs-bristle beard."

As these letters show, he was not only a man of outstanding intellectual gifts, but possessed a really rare personality. As we have seen, he was descended from Olof Rudbeck, and some of the blood of the author of "Atlantis" flowed in his veins. This is revealed by his will, with its merits and its defects. Its aim is lofty, loftier perhaps than the means available justified, but he too, like his ancestor, believed in Atlantis. The one conceived it as the Sweden of ancient times, the other as the new order for mankind in the future. He himself lived largely in this dream country, and he wished, through his generosity, to pave the way to it for mankind. He shewed himself a true descendant of Rudbeck in his tireless industry, the many-sidedness of his interests, and his dominating intelligence which, while adapted for practical tasks, always had a streak of exalted idealism and of poetry. In Alfred Nobel survived something of Sweden's great period.

His death did not come as a complete surprise; from his earliest youth Nobel had been delicate, and his parents' letters often referred to his indifferent health. As has been mentioned, he had to go to a Spa when he was only twenty, and during his whole life he had to take similar cures. His strenuous work and constant travelling naturally also undermined his constitution. His letters therefore often harp on the theme of death; thus in 1889 he wrote: "As you well express it, I have great things to think about, at least one great thing—the passing from light to darkness, from life into the eternal unknown or, as Spencer calls it, the unknowable. You remember, no doubt, the thoughtful line of an English poet (Campbell): 'Coming events cast their shadows before.' It is especially the case with that event, which puts a fullstop to further events."

But his energy was such that he kept going. In 1893 he reached

the age of sixty, and from that time onwards his attacks became more serious. In 1894 he wrote to Liedbeck: "I am almost in a worse way than before, as I have had these rheumatic devils paying a visit to the heart muscles or thereabouts for some days, and feel then that any moment eternity may be welcoming me with open arms." In a letter written in February, 1896, he writes: "Since you left, my heart has always been subject to visitors from Niflheim, has been afflicted with earthly demons too. Two idiots of specialists attribute the trouble, one to rheumatic gout, and the other to gouty rheumatism, a kind of jargon which is no explanation of the fact that my heart pounds like a horse, although there is devilish little of the horse about me."

Two months before he died he wrote: "As you may know, I have come here (to Paris) to consult a famous specialist for diseases of the heart, and both he and my own doctor state that it is impossible for me to continue for long to work as hard as I have been doing hitherto, with such an advanced calcination of the aorta. This does not mean that I must be idle, but only that I must as far as possible avoid strenuous travelling." In another letter, written the following day to his assistant Sohlman, he said: "My heart trouble will keep me here in Paris for some days certainly, until the consultants are quite clear as to the best method of treatment. It seems an irony of fate that they should be prescribing nitroglycerine internally for me. They call it trinktin, to avoid terrifying the chemists and the public."

On the 21st November he returned from Paris to Mio Nido in San Remo, and judging by his letters, he seems to have felt comparatively well at this time. Several of these letters refer to Andrée's flight to the North Pole, and they demonstrate his keen and undiminished interest in Swedish research. His last letter to Sohlman, quoted above, was written on the 7th December, and runs as follows: "The samples you have sent are particularly good.

The pure nitro-cellulose powder seems to me to be splendid. Unfortunately my health is so bad again that it is difficult for me to write even a few lines, but as soon as I can I shall return to the matter which interests us." This was not to be ; only a few hours later he had a stroke, and on the night of the 10th December, 1896, he died. The first funeral service was held at Mio Nido ; one of his more recent friends, Nathan Söderblom, the young pastor at the Legation in Paris (now Archbishop of Upsala) went to San Remo in order to pay his last tribute at the bier.

He said in the course of his address : " It was a natural corollary of the loneliness and suffering that were his lot, that in the public estimation he should have figured too much as a rich and remarkable man, too little as a human being. Let us not perpetuate this error now that he is dead ; for to the life beyond the grave we can take neither our possessions nor our achievements ; and we must leave behind our earthly happiness too. In such happiness the dead man may well seem to us, despite all his possessions and the affection of his associates, to have been poor enough ; it was his choice or his fate to live alone, and he died alone, without a hearth to cheer him or the hand of son or wife to smooth his brow. And his was not a nature to be hardened by money or success, or to be embittered by loneliness ; to the end of his life he was warm-hearted and kind. In the life beyond all that matters is to have lived nobly."

His ashes were brought from San Remo to Sweden, and the solemn funeral took place in the Storkyrka in Stockholm, on the 29th December. In accordance with his wishes, his last resting-place was in the family grave, in the Northern Churchyard, where his parents and his brother had been buried before him.

THE WILL

IN a letter dated the 3rd March, 1889, Nobel wrote to an acquaintance in Stockholm: "Would you be so kind as to ask a Swedish lawyer to prepare a suitable form for my Will. My hair is grey, I am worn out, and I must prepare for shuffling off my mortal coil. I ought to have done so long ago but I had so many other things to attend to."

This passage seems to imply that Nobel had not made any previous Will. Further it should be noted that he said nothing as to the terms of the Will he had in mind, and only asked for a specimen form, within the framework of which he intended to draft the various provisions. The two Wills that we know were prepared without the assistance of a lawyer, but the form which was sent him was naturally so general in its terms that it could hardly be of much practical use. His numerous lawsuits had instilled in him a profound distrust of all lawyers, and as a practical business man he hated "those niggling parasites" as he called them. The result of this attitude was that he did not entirely succeed in clearly expressing his intentions in his Will.

He received the specimen form at the end of March, and it appears that his friend reminded him in his letter of the Stockholm University, since Nobel replied on the 30th March: "Thank you for the specimen form of Will. I shall consider the University, but I have not made up my mind whether it is better for young people to graze like Nebuchadnezzar, or to pore over books. It is a difficult problem. I believe that His Majesty of Babylon would

have been awarded the Grand Cross of the Order of Pleasure rather than the greatest of philosophers." As we shall see, Nobel did allot an endowment to the University, although he afterwards changed his mind.

It is not known how far he went in completing a Will in 1889, but as his Will of 1893 expressly "rescinds the provisions of any previous Will," we may infer that there were one or more previous Wills although they have not been discovered. The oldest that has been preserved was made in Paris; it is dated the 14th March, 1893, and witnessed by Thorsten and Per Nordenfelt, C. Stein Nielsen and Sigurd Ehrenborg. This Will specifies no definite amounts, but it opens by leaving certain percentages of his property to individual persons. These persons, friends and relations, are fairly numerous, amounting to twenty-two. Altogether 20 per cent of his property was allotted to them. In addition he allotted certain percentages to the following societies and institutions: The Swedish Club in Paris; the Austrian Society of the Friends of Peace at Vienna, "to be expended on the promotion of pacific ideas"; the Stockholm University "to be expended as the governing body may deem most suitable"; the Stockholm Hospital "to be expended as the governing body of the Karolinska Institute shall determine." He also endowed the Karolinska Institute itself with a sum "out of which a fund shall be formed, the interest on which shall be devoted every third year, in accordance with the decision of the governing body, as a prize for the most important and original discovery or invention in the field of physiology or medicine." Seventeen per cent of his property was earmarked by Nobel for these bodies. The Will continues as follows: "I leave the whole residue of my estate to the Academy of Sciences at Stockholm for the purpose of forming a fund, the interest on which shall be distributed by the Academy each year as a reward for the most important and original discoveries or intellectual achievements in the wide field of

knowledge and progress, excluding physiology and medicine. Although I do not make it an absolute condition, it is my wish that such persons should be especially considered as are successful either in word or deed in combating the peculiar prejudices still cherished by peoples and governments against the inauguration of a European peace tribunal. It is my definite wish that all prizes contemplated under my Will shall be awarded to the most deserving without any regard to the question whether he be a Swede or foreigner, a man or a woman."

The Will further stated: "I desire that the considerable sum which will probably be payable in respect of Royalties shall be devoted to the erection of crematoria in large cities, and I hope that the governing body of the Karolinska Institute in Stockholm will undertake to appoint the body to which this matter, which is of such vital importance for the welfare and health of society, should be entrusted." It is obvious that this Will was a much more effective instrument than the later one, since definite trustees are indicated in it. There is a further difference between this and the final document in that this document does not appoint the Storthing or the Swedish Academy as distributors of prizes. In the older Will the powers now exercised by these institutions were left to the Academy of Sciences as far as the Peace prize is concerned, subject to the exercise of a certain discretion. There is no mention of any prize for literature, but since the Will states that the Academy of Sciences shall not only distribute prizes for physics and chemistry as it does at present, but also "for the most important and original discoveries and intellectual achievements in the wide field of knowledge and progress, excluding physiology and medicine," the Academy would also have been able to allot prizes for good literature as well as for etymological, biological, mathematical or other achievements. It is not quite clear whether Nobel had in mind that only one prize should be awarded annually (*e.g.*, for physics),

or that several prizes should be awarded in respect of various sciences. The former seems the more probable, *i.e.*, that one year a prize should be awarded for physics, and in the following year for chemistry, and so on.

One further difference between the two Wills should be mentioned. According to the older Will the Peace prize was to be awarded to the person who had most actively worked for the establishment of "peace tribunals," while according to the later Will the prize was to be awarded to the person who had "worked most effectively in the interests of the brotherhood of nations, the elimination or reduction of standing armies, and the institution and popularisation of peace congresses." This Will then makes no reference to a peace tribunal, and efforts to secure the establishment of such tribunals render a person eligible for the prize only in so far as they can be regarded as tending to promote the brotherhood of peoples. It is improbable however that the altered wording indicates any change of intention.

Meanwhile, although not departing from the main conception, Nobel altered the provisions in certain points. It is possible that he reflected upon the difficulty, not to say the impossibility, of the Academy of Sciences estimating the relative merits of a discovery in the realm of physics or chemistry as against an achievement in the direction of maintaining peace. In certain matters he actually changed his mind. Thus the Stockholm University, the Austrian Society of Friends of Peace, and other institutions were cut out as direct beneficiaries. He transferred from the Academy of Sciences to the Norwegian Storthing the duty of awarding a Peace prize, probably being influenced by his sympathy for Bjornson and other Norwegian poets. Finally, his new interest in poetry seems to have directed his attention to the Swedish Academy. The second Will was made in November, 1895, that is during the period when he was engaged on the drama "Nemesis." Another reason inducing

him to alter the Will came to light during the subsequent examination of the witnesses to the Will. One of them mentioned certain conversations which had taken place between him and Nobel in 1895 and 1896, and in which the Will was touched upon. On the latter occasion, *i.e.*, on the 29th September, 1896, another of the witnesses to the Will had been present. Nobel had on that occasion stated: "I am an out and out Social Democrat, although my views are moderate. In particular I regard large inherited wealth as a misfortune which merely serves to dull men's faculties. A man who possesses great wealth should therefore allow only a small portion to descend to his relatives. Even if he have children I consider it a mistake to hand over to them considerable sums of money beyond what is necessary for their education. To do so merely encourages laziness, and impedes the healthy development of the individual's capacity to make an independent position for himself."

The other witness who was present at the conversation on the 29th September, 1896, quoted Nobel in almost exactly the same words. This is entirely consistent with a remark of Nobel's contained in his draft law previously referred to, *I ljusaste Afrika*: "I am not a Socialist in the popular sense of the word. But in my state there is a constant interaction between the individual and the community, and if the state misconceives the rights of the individual it will misuse and undermine its own. Bellamy's absolute equality, which after all cannot obliterate the inequalities of nature, would merely produce an almost mechanical barrack life, the horizon would be far too limited for the individual to find a stimulus to intellectual work. Where the driving force is absent men begin to vegetate; the people must choose between progress and retrogression. Absolute stability is impossible. . . . It is certain that a large inheritance is for many persons a misfortune, and young persons of vast possessions are often those whose destinies are blighted."

The second Will was signed on the 27th November, 1895, at the Swedish Club in Paris, being witnessed by Lieutenant Sigurd Ehrenborg, Thorsten Nordenfelt, Court official, R. W. Strehlenert, engineer, and Leonard Hwass. The Will begins with the words: "I the undersigned Alfred Bernhard Nobel hereby declare after mature consideration that my last Will with regard to the property which I may leave on my death is as follows:"

The Will first enumerates certain small legacies to individuals, and then proceeds as follows:

"With the residue of my convertible estate I hereby direct my Executors to proceed as follows: They shall convert my said residue of property into money, which they shall then invest in safe securities; the capital thus secured shall constitute a fund, the interest accruing from which shall be annually awarded in prizes to those persons who shall have contributed most materially to benefit mankind during the year immediately preceding. The said interest shall be divided into five equal amounts, to be apportioned as follows: One share to the person who shall have made the most important discovery or invention in the domain of Physics; one share to the person who shall have made the most important Chemical discovery or improvement; one share to the person who shall have made the most important discovery in the domain of Physiology or Medicine; one share to the person who shall have produced in the field of Literature the most distinguished work of an idealistic tendency; and, finally, one share to the person who shall have most or best promoted the Fraternity of Nations and the Abolishment or Diminution of Standing Armies and the Formation and Increase of Peace Congresses. The prizes for Physics and Chemistry shall be awarded by the Swedish Academy of Science (Svenska Vetenskapsakademien) in Stockholm; the one for Physiology or Medicine by the Caroline Medical Institute (Karolinska institutet) in Stockholm; the prize for Literature by the

Academy in Stockholm (*i.e.*, Svenska Akademien) and that for Peace by a Committee of five persons to be elected by the Norwegian Storting. I declare it to be my express desire that, in the awarding of prizes, no consideration whatever be paid to the nationality of the candidates, that is to say, that the most deserving be awarded the prize, whether of Scandinavian origin or not.

" I appoint as executors of my Will Ragnar Sohlman, resident at Bofors, Vernland, and Rudolf Lilljequist of 31, Malmskilnadsgatan, Stockholm, and of Bengtsfors near Uddevalla.

" This is my only valid Will and cancels any previous testamentary dispositions that may come to light after my death.

" It is moreover my express will and injunction that my veins shall be opened after my death, and that when this has been done, and competent doctors have noted definite signs of death, my body shall be burned in a crematorium.

" Paris, the 27th November, 1895. Alfred Bernhard Nobel."

Nobel had drafted his Will alone and without the assistance of any legal adviser, with the result that, as has been stated, it suffers in many respects from faulty construction. He handed over his property but to whom ? This is not stated, but only that certain bodies should award five prizes out of the interest. Neither did he make any provision for the administration of the funds. Moreover he assumed that the two academies, the Karolinska Institute and the committee of five men to be selected by the Norwegian Storthing, would be sufficiently conversant with current literature, with the most recent discoveries in the realm of physics and chemistry, and with contemporary peace movements to be able easily to decide what achievements or discoveries of the previous year had been of the greatest importance. Such an assumption is particularly remarkable in the case of a man like Nobel, who was himself a man of science. Since, moreover, in certain circumstances the trust might be exceedingly onerous and interfere with the proper

duties of the bodies in question, there was the possibility that they might refuse to accept the responsibility which the testator sought to impose upon them. If one or all of these bodies were to refuse to act, what would be the position? Would the Will be declared invalid? These were all matters giving rise to the possibility of dispute and complication, as indeed happened, although such difficulties might easily have been avoided if the Will had been drawn up by a competent lawyer.

In any case a strictly literal interpretation of the Will would hardly have served to carry out Nobel's intentions on essential points. This is especially true of the provision that the interest should be awarded "annually" in respect of the most important discovery or invention that had been made "in the previous year." It is frequently difficult to ascertain the exact moment of achieving a discovery which has required many years of preparatory work. Moreover there are obvious objections to awarding a prize for a discovery, the importance of which has not been tested and proved. This consideration was all the more important since it was undoubtedly Nobel's intention that the prize should be awarded for discoveries of real value.

Moreover it is obvious that Nobel's primary desire was to help those who required his assistance for their work. We may assume that he felt himself under a certain debt to the pioneer research workers in pure science, whose discoveries he had turned to practical account for meeting the requirements of everyday life. It is therefore beyond doubt that Nobel wished those men of science who had successfully devoted themselves to research, without regard to any personal advantage that they might derive from their work, to benefit from the income of his estate. He held the view that purely scientific work can only in exceptional cases be fairly estimated in terms of money, and rewarded in a manner commensurate with its importance for mankind. This is also shown by

Nobel's own statements, as recorded by one of the witnesses referred to above: " In this connection I feel I ought to say that Doctor Nobel stated on several occasions that he wished primarily to be of service to research workers, since they generally find it more difficult to turn their successful discoveries to profit, these being generally exploited by others. On the other hand, he used to say that a technical expert who was industrious, energetic and resourceful, would have less difficulty in making his way and reaping the reward of his efforts himself." As the Will is drafted, however, it is impossible to take such considerations into account. A Rothschild who had " made the most notable contribution to imaginative literature" would necessarily win the prize for literature, and a physicist who had made a discovery worth millions to him would under the Will be entitled to the prize for physics if the discovery were such as to deserve it, although neither event would be in accordance with Nobel's real intentions. His intention was, not to confer distinctions for scientific achievement, but to render help where help was needed. One of the witnesses to the Will made the following statement: " It was absolutely his intention that the prize winners should be awarded the very considerable sums provided for under the Will. I am convinced from my conversations with Doctor Nobel that he was not in the least interested in giving small sums as a reward without any real use. His desire was, as he always stated, to place those whose work showed promise in a position of such *complete independence* that they would in the future be able to devote their whole energies to their work. His wish was not to reward work that had been done, or talents that showed promise, but to give an opportunity for fruitful development." Another witness stated: " The undersigned hereby testifies that Herr Alfred Nobel, in the course of conversation, made the following statement to him, which may possibly assist in the interpretation of his Will. A few months

before his death he said: 'I would not leave anything to a man of action; as he would be tempted to give up work. On the other hand I would like to help dreamers as they find it difficult to get on in life.'"

Dreamers such as possess the gift of poetry, but are unknown to the many or are misunderstood by them, imaginative young scientific investigators who are on the very threshold of a discovery in physics, chemistry or medicine, but lack the means to achieve it—such were the persons whom Nobel wished to help, but the wording of the Will is such that it cannot be interpreted in this sense.

Thus Nobel did not quite succeed in expressing what he wished in his Will. At the same time he regarded it as a document that should merely lay down the general lines in accordance with which the provisions might be applied *to the greatest benefit of mankind.* This was for him the supreme consideration, and in this connection the following statement is of the greatest importance:

"I am firmly convinced, as a result of my conversations with Doctor Nobel, that it was not his intention that the Will should be interpreted in a strictly literal sense. Indeed the fact that he omitted to give detailed instructions is an indication of the fact that he desired to leave the greatest possible latitude to those entrusted with its execution. This would moreover be entirely in accordance with his character. When he had once decided to place confidence in a man, he did so fully and unreservedly, without the imposition of petty restrictions. The essential thing for him was to feel the sense of personal confidence. And Doctor Nobel said to me more than once, that he had entrusted the Swedish Scientific Institutions with the duty of awarding the prizes, because it was in Sweden that he had met the greatest proportion of honourable men, and therefore felt that his last Will would be carried out here in Sweden more scrupulously than elsewhere. Since, as has been stated, Doctor Nobel was not accustomed to lay down detailed

instructions when entrusting persons with responsible work, I do not believe that he was concerned as to the manner in which his Will would be interpreted in detail. At any rate he never discussed this with me."

This is confirmed by another witness: "Doctor Nobel made no direct statement to me as to his intentions with regard to the detailed interpretation of his Will, but from his references, remarks and observations on these matters I have come to the conclusion that he wished to leave to the trustees all the liberty that was consistent with a due regard for the spirit and principal intention of the Will. This is entirely consistent with his habit, when entrusting a person with an important work, of laying down only the general object to be aimed at, without prescribing as to the method by which that object was to be achieved."

Alfred Nobel died on the 10th December, 1896. The first problem that the two executors had to solve was the question of his domicile.

As has already been shown, Alfred Nobel frequently changed his home during the course of his life. He had left Sweden at the age of nine, and had not appeared on the tax roll since. He had spent the years of his development partly in Russia and partly on journeys in various countries. His longest consecutive period of residence was spent in Paris, and at his death he still owned the house in the Avenue Malakoff which was kept ready for him to occupy when he came to Paris. During the last five years of his life, however, his principal place of residence had been San Remo, where he spent the winters, and finally Bofors, where he was accustomed to spending part of the summer.

He had always retained his Swedish nationality, and according to Swedish law, therefore, the execution of his Will was undoubtedly subject to the Courts of that country. On the other hand it was open to doubt whether questions connected with the Will were

within the competence of the Court at Stockholm where Alfred Nobel had last been registered as a tax payer, or of the Court at Bofors where he had last lived. Lest there should be any mistake the executors registered the Will at both places.

The executors having submitted a certified copy of the Will through the Ecclesiastical Department to His Majesty the King, with a covering letter in which they humbly requested that His Majesty's Government would be pleased to inform them of the measures it should deem suitable with regard to it, the Attorney General made the following statement on the 6th May, 1897. After reciting the Will itself the statement proceeded as follows: "As appears from the provisions of the Will quoted above, no portion of the testator's estate is left directly or indirectly to the State or Crown of Sweden. Under the Will the residue, after providing for the payment of legacies to individual persons, shall constitute a fund, the interest on which shall be distributed as prizes for the benefit of such persons, without distinction of nationality, as shall have rendered the greatest services to mankind in a manner that is particularised in the Will. In these circumstances it does not appear to be necessary for the protection of any rights of the Swedish State or Crown that the Will, which has been registered in the Courts by the duly appointed executors, should also be registered in the interests of the State.

"As, however, when the Will has been duly recognised, the Foundation in question will amount to several million Kronen in value, and has been instituted by a Swedish subject for general purposes, so that the administration of the Foundation will be carried out in this country; as the competent academies, etc., appointed under the Will for awarding the prizes, are thereby created to a certain degree the executive organs of the endowment, having not merely duties but also corresponding rights; as in view of these facts a special registration of the Will may be of value

for reasons of State or the public benefit, since this would amongst other things serve to indicate that the State of Sweden as far as it or its subordinate departments is concerned, is prepared to collaborate in the execution of the Will; and as this case is one of more than ordinary importance, so that nothing should be omitted that might assist in any way in carrying out the lofty intentions of the testator, the Attorney General is of opinion—subject always to the assumption that the duties imposed by the provisions of the Will upon Swedish public bodies will be accepted by them—that it is desirable to take the necessary measures to have the Will specially registered by the State in the interests of the public good. The duties referred to undoubtedly impose onerous duties and responsibilities upon the public bodies, and as regards any expenses which may be involved in connection with carrying out these duties, the Attorney General is of the opinion that in the nature of the case these, as well as the expenses of administration, should be borne by the estate. If Your Majesty agrees that the opinion above expressed by the Attorney General is correct, the Attorney General should be instructed as speedily as possible to take the necessary steps to ensure that the Will is specially registered by the State on behalf of the community."

Accordingly the Government instructed the Attorney General on the 21st May, 1897, to make the necessary legal arrangements required in the interests of the State and the community in order to give validity to the Will. At the same time the Government requested the Swedish Academy, the Academy of Sciences, and the Chancellor of the University to carry out the measures necessary to enable the Academies in question, as well as the medico-surgical Karolinska Institute, to take advantage of the co-operation of the Attorney General's department for the same purpose.

Thus apart from the legal registration by the executors, the Will was also legally registered, the necessary measures having been

taken by the Government, in the name of the Swedish State, the community, the Swedish Academy, the Academy of Sciences, and the Karolinska Institute. The Norwegian Storthing also arranged for a special registration.

The question of competence in Sweden was decided by a friendly action brought by one of Nobel's heirs against another, the executors intervening as an interested party with the demand that Karlskoga (Bofors) should be recognised as the Court competent to deal with matters affecting the Will. This claim was admitted and recognised by the courts.

It was by no means settled, however, that foreign Courts, especially the French, would come to the same conclusion on the problem of competence. Indeed it seemed probable that if the matter should come to be more closely investigated, as for instance any dispute regarding the validity of the Will, the French authorities would put forward the view that, through his long residence in France and his acquisition of an estate in Paris, Alfred Nobel had acquired a French domicile, "domicile de fait." The primary result of such a conclusion would have been that estate duty would have been payable in France in respect of the whole property. Another consequence would have been that the French Courts might have regarded themselves the competent authority to decide the validity of the Will; and in view of its legal blemishes, especially from the point of French law, the whole Will might in that case have been declared invalid.

The executors had called in as their first legal adviser, especially for the negotiations with the institutions upon whom the duty of awarding prizes would devolve, Carl Lindhagen, who was then a justice in the Court of Appeal and is now a burgomaster. Prominent lawyers of various countries were also asked to advise on judicial questions, in Sweden, Judge H. Santesson, in France, Monsieur Waldeck-Rousseau and Maître P. Coulet, in England and

Scotland, a prominent Scottish lawyer, Mr. Warren, in Germany, Dr. Scharlach and Dr. Westphal of Hamburg, etc.

As it was obvious that the testamentary provisions required amplification, and in certain cases adaptation, before they could be applied in practice, one of the first and most important tasks was to secure the co-operation of the various prize-giving bodies to this end. The executors accordingly wrote to the bodies concerned in Sweden as well as to the Storthing, requesting, them to accept the duties imposed upon them under Nobel's Will, and at the same time to appoint delegates to discuss with the representatives of the other prize-giving bodies, and with the executors of the Will, the special arrangements to be made and the method to be adopted in the distribution of the prizes.

The attitudes taken up by the bodies concerned were at first very various. The Norwegian Storthing resolved as early as the 26th April, 1897, to agree to act under the provisions of Nobel's Will, and in the same year it appointed both the members of the Committee of five men who would have to undertake the duty of awarding the prizes, and the delegates to carry on the negotiations with the executors and the remaining prize-awarding bodies regarding the Articles of the Foundation to be created. The Swedish Academy and the Karolinska Institute declared that they were also prepared, on the understanding that a scheme could be prepared to elucidate the Will in the manner necessary, to act under the provisions of the Will, and they also appointed delegates for the negotiations.

The Academy of Sciences took up a more cautious attitude, stating in a letter to the executors dated the 30th June, 1897, that the Academy did not regard it as practicable, or indeed as desirable, before the Will had been legally recognised, to make definite proposals for preparing a scheme to elucidate it, with a view to avoiding the difficulties that might arise through its literal inter-

pretation, and that the Academy therefore could not see its way to appoint delegates for the purpose of making such suggestions.

Now it was essential, if the Will were to survive a dispute and be recognised by the Courts, that the prize awarders, as representing the administrators, should declare that they were prepared to accept the trust imposed upon them, so that matters appeared to have reached a deadlock.

Nevertheless certain preliminary discussions took place between the delegates designated by the Swedish Academy and the Karolinska Institute, and the executors. These discussions, which took place at a number of meetings during the years 1897 and 1898, were attended by two members of the Academy of Sciences of their own initiative. Doctor Emanuel Nobel, who represented the Russian branch of the family, attended several of these meetings.

From these discussions the possibility emerged of arriving at formulæ for carrying out the provisions of the Will such as could solve the difficulties arising out of the drafting of its provisions, without affecting the fundamental intentions of the testator. Thereupon Doctor Emanuel Nobel made a statement at the meeting held on the 11th February, 1898, which was practically decisive in bringing the Nobel Foundation into being. We give below the minutes of this meeting, at which there were present besides Doctor Nobel, Doctor Af Wirsén, Professors Count Morner and Pettersson, the executors, and the drafting secretary Lindhagen.

§ 2

" Herr Nobel stated that he desired to respect the intentions and wishes expressed in the Will of his deceased uncle. He would therefore not dispute anything contained in the Will. In order however to give effect to the lofty intentions of the testator, alterations and supplementary provisions were undoubtedly

required, and these could not be introduced without the consent of all the heirs.

"Herr Nobel therefore asked that any proposals of this kind should be communicated to him in each individual case, so that he could consider whether they were in harmony with the wishes of the testator, and decide whether he could concur in them himself and on behalf of those whom he represented.

"The other persons present stated that they regarded it as a matter of course that Nobel's heirs should be asked their opinion regarding any such scheme. Herr Sohlman added on behalf of the executors that they had always desired to act in agreement with all the beneficiaries in the execution of their office, and that in view of Herr Nobel's attitude to his uncle's Will they would in the future, as they had in the past, regard it as their right and their duty to have recourse to his advice and assistance in dealing with the inheritance, and arriving at a satisfactory solution of the problems connected with the Will."

As it might now be regarded as settled that the Will would be duly recognised, at any rate by that section of Alfred Nobel's heirs that represented the interests of the section of the family domiciled in Russia (or about eight-twentieths), the Academy of Sciences decided on the receipt of further representations from the executors to appoint delegates to attend the discussions regarding the Articles of the Foundation.

Meanwhile Nobel's other heirs in Sweden brought an action against the executors in which they claimed that the Will should be declared invalid on technical grounds, more especially because it failed to appoint an actual representative of the principal beneficiary, namely the Foundation to be created under the Will. At the hearing the plaintiff heirs stated that on winning their case they would endeavour as far as the matter lay in their power, to carry out the main intentions of Doctor Nobel's Will.

After prolonged negotiations, two separate agreements were concluded on the 29th May and the 5th June, 1898, between, respectively, the executors and the plaintiff heirs, whereby they undertook on behalf of themselves and their heirs to recognise the Will, subject to certain conditions, and to waive any further claims upon the estate.

These agreements secured certain pecuniary advantages to the heirs, of the total value of about one-and-a-half year's income to the estate.

The agreement of the 5th June, 1898, contains the following stipulations:

"That the Articles of the Foundation dealing with the conditions governing the award of the prizes provided for under the Will should be drawn up in agreement with a representative appointed by the family of Robert Nobel, and that they should be submitted to His Majesty's Government for approval.

"That the following main principles should be strictly adhered to; namely that each of the annual prizes provided for under the Will should be awarded at least once in every period of five years, to commence with and include the year subsequent to that in which the Nobel Foundation should come into force; and that in no circumstances should the amount of such a prize, when awarded, be less than 60 per cent of the total amount of accumulated interest available for distribution, and that the amount should never be divided into more than three prizes."

This agreement was approved by the Government, whereupon the action regarding the validity of the Will was withdrawn. It was now possible to embark upon the final discussion regarding the Articles of the Nobel Foundation. These were carried on by a committee consisting of the representatives of all the prize-awarding bodies, of both branches of the Nobel family, and of the executors of the Will.

The committee's deliberations were continued in a series of meetings during the years 1898 and 1899 under the Presidency of Herr von Ehrenheim, the last meeting being held on the 28th April, 1899. The result of these negotiations was embodied in "draft articles of the Nobel Foundation" which were submitted by the executors for examination and approval by His Majesty the King. When the Attorney General had given his opinion, the draft articles were passed by the Government, subject to comparatively unimportant alterations, mainly of a technical nature. This was done on the 29th June, 1900.

Meanwhile the executors had been proceeding in the ordinary way with the realisation of Nobel's assets, the winding up of the estate, and the payment of individual legatees.

Alfred Nobel had left property not only in Sweden, but also in France, Italy, England and Scotland, Germany, Austria and Russia, as well as in Norway, the property in the latter country consisting only of patent rights. In accordance with the regulations regarding estate duties in France, Italy, England, Scotland and Russia, special assessments of the value of the property left in those countries were made, on the basis of which a total assessment was made at Björkborn, near Bofors, on the 30th October, 1897, and handed in to the district court at Karlscoga.

According to the assessment the property left in these countries was valued as follows:

	Swedish Kronen
In Sweden	5796140,—
„ Norway	94472,28
„ Germany	6152250,95
„ Austria	228754,20
„ France	7280817,23
„ Scotland	3913938,67

	Swedish Kronen
In England	3904235,32
„ Italy	630410,10
„ Russia*	5232773,45
Total:	33233792,20
Liabilities and Deductions	1646589,92
Total net value of estate.	31587202,28

Estate Duty paid abroad amounted to . .	1325949,96
„ „ „ to the Swedish State . .	1843692,25
Total Estate Duties:	3169642,21

Legacies to individuals amounted to about .	1370000,—

After the disbursement of legacies and of estate and other duties, as well as the expenses of winding up the estate, and the payments arising out of the agreement settling the action contesting the Will, the final settlement made by the executors after finally concluding their administration of the Nobel Fund on the 31st December, 1900, left an amount of 31,225,000.36 Kronen to the credit of the Nobel Foundation.

The final settlement had necessarily taken a considerable time, since complications had arisen at various points, some of which, owing to the contentious nature of the questions involved, could

* There were in addition to Russian securities to the value of 1,691,000 Kronen on deposit in Germany.

not be settled without litigation. This indeed is only natural when we consider the magnitude of the estate, the fact that it was distributed throughout several different countries, the size and in some cases the complicated nature of the individual undertakings in which Alfred Nobel had been interested, and the fact that the executors were necessarily often in doubt as to the best way of winding up the business that represented his many and varied activities. It is impossible to give more than a short summarising sketch of the manner in which such problems were dealt with.

The various kinds of shares, etc., in foreign companies, consisting altogether of some hundreds of different varieties of securities, were generally dealt with by being sold on the Stock Exchange.

Alfred Nobel's furnished house in the Avenue Malakoff, as well as that at Björkborn, were sold by public auction. The villa at San Remo was bought with its furniture by one of Nobel's German business friends, Max A. Philipp of Hamburg.

Alfred Nobel's holding in the Nobel Brothers Russian Naphtha Company was acquired by the Russian branch of the family. The previous owner succeeded in forming a syndicate to take over Nobel's shares and interests in Bofors, so that the works there remained in Swedish hands and were able to develop on their previous lines.

In connection with the winding up of experimental undertakings the executors decided to allow Alfred Nobel's laboratory at Björkborn to carry on its operations for one year, and that the contracts with the various inventors whose research work was financed by Nobel should remain in force for one year. This decision produced results that were also financially satisfactory.

Alfred Nobel's library of literary and scientific works, his archives containing his correspondence and a large number of papers relating to his inventive activities, as well as a number of selected objects of interest in his laboratory, have been preserved, and

handed over to the Nobel Foundation to be placed in a Nobel Museum.

The trustees elected under the Articles of the Nobel Foundation met for the first time on the 27th September, 1900, to elect the Board of Management of the Trust. This Board took over the administration of the funds of the Foundation and its income.

APPENDIX I

(*See page* 143)

MR. JUSTICE ROMER'S JUDGMENT IN THE "CORDITE CASE."

Mr. Justice Romer then delivered judgment for the defendant as follows:

"Notwithstanding the complexity of the case, as I have come to a clear conclusion on the essential questions to be decided, I will not postpone my judgment. The important point to be ascertained is what was the invention covered and claimed by Mr. Nobel's patent of 1888, the subject of this action. So far as material for the purposes of this action it was the manufacture in manner described by the patentee of a horny or semi-horny explosive susceptible of granulation from nitro-glycerine and soluble nitro-cellulose. It becomes, therefore, important to consider what was meant by the patentee by the term 'soluble nitro-cellulose.' Now, at the date of the patent, nitro-cellulose consisted of two well-known and distinct kinds—the soluble and the insoluble. The soluble was commonly called collodion cotton or (sometimes) collodion gun-cotton, and was principally, though not exclusively, used for photographic or surgical purposes. The insoluble was commonly called gun-cotton, meaning thereby the gun-cotton used for explosive purposes. The terms soluble and insoluble were given to these two classes because, speaking generally, the first was soluble and the second was insoluble in ether alcohol. But of the two kinds, as made and sold at the date of the patent, the soluble contained a small percentage of the insoluble and the insoluble contained a part (about 12 per cent) of soluble. These two kinds

were not only distinguished as well-known objects of manufacture and sale, but were also often distinguished, though to my mind not very satisfactorily, as di-nitro-cellulose and tri-nitro-cellulose, with separate chemical formulæ. The reason of this probably arose from the fact that as a rule the solubility of a nitro-cellulose varies with the amount of nitration and that the soluble kind approximates more or less, though not very closely, in degree of nitration to that which, if quite perfect, would be correctly described chemically as di-nitro, while the insoluble kind approximates, though not very closely, to that which, if quite perfect, would be correctly described chemically as tri-nitro. It is true that by certain special means, and as a laboratory experiment, you could make soluble nitro-cellulose with a somewhat high degree of nitration, but this fact may in my opinion be disregarded for the purpose of the present case, for such special kind of nitro-cellulose was not manufactured or sold, and was not in my opinion referred to or considered by the inventor, Mr. Nobel, in his invention and claim as set forth in his specification, and has never been used in the manufacture of ballistite (as the plaintiff's powder is called) or of cordite (as the defendant's powder is called). Now, in addition to the above, there were further distinctions between the soluble and the insoluble nitro-cellulose which in my opinion have a very important bearing with reference to this case. In the first place, the insoluble was a more violent explosive than the soluble, and at the date of the patent was regarded as being more dangerous to work with, especially if heat were employed in the process; and, in the second place, nitro-glycerine acted as a solvent differently on the two kinds, having substantially no effect as a solvent on the insoluble kind. Now, turning to the plaintiff's specification, it is clear to me that in his patent and claim the patentee meant by soluble nitro-cellulose the well-known soluble article which I have described, and not the soluble. I come to this conclusion

on many grounds, of which I may mention the following. In h
provisional specification he speaks of the nitrated cellulose to b
employed as the well-known soluble kind, and in his final specif
cation, after stating his object generally, where he speaks of nitro
cellulose without specifying the kind, he subsequently throughou
speaks of soluble and no other nitrated cellulose, and his claim a
the end is limited to soluble nitro-cellulose. Moreover, in one par
of his specification he refers to the use of certain facilitating solvents
and, while all of these are solvents for the soluble kind, some o
them are not solvents for the insoluble kind of nitro-cellulose. Moreover, camphor, the use of which is much relied on by the patentee, has substantially no solvent effect on the insoluble kind. And in another part of his specification the patentee refers to the materials he uses as being the same in kind as the ingredients used by him in the substance known as blasting gelatine, for which he had obtained a patent in 1875, and the nitro-cellulose mentioned in that patent, and in fact and practice alone used in the manufacture of that substance, was the soluble, and not the insoluble, kind, and is referred to in the specification of that patent indifferently as collodion cotton, collodion gun-cotton, nitrated cotton, and soluble nitro-cellulose. Moreover, near the commencement of the specification of the patent of 1888 he refers to a substance called "celluloid," which is partly made of camphor, and he points out that what he is doing by his invention is to replace that camphor by nitro-glycerine so as to obtain his object, and on the balance of the evidence I am satisfied that celluloid was and is made by mixing camphor with collodion cotton, and not with gun-cotton. And in his provisional specification, at page 2, line 13, where he is referring to the well-known fact that the soluble always contains some small part of insoluble, he points out that to avoid too great quickness of explosive power in his propulsive product the less of the insoluble there is in the nitro-cellulose the better. And in his

final specification, at page 5, line 5, he points out the necessity or advantage of great solubility. As against these considerations I find substantially nothing but an ingenious, but to my mind delusive, argument founded on a calculation by a witness that if you take the example given by the patentee at page 5, line 52, omit the word " almost " before the word " exactly," you would obtain a result showing high nitration in the nitro-cellulose, and that, therefore, though he there calls his cellulose soluble, he meant either the insoluble or the very special laboratory form of soluble with high nitration that I before referred to. I do not think the patentee meant or contemplated anything of the kind. The patentee has, therefore, confined his claim to the manufacture from the soluble nitro-cellulose, and in his opinion he has selected the soluble as distinguished from and (in a sense) as opposed to the insoluble. Any of the persons to whom this specification was addressed would, I think, from reading it with the then state of knowledge, be led to the conclusion that to carry out the patentee's invention he was to avoid the use of the insoluble form. Certainly no one from reading the specification with the then state of knowledge would have been led to make a powder by combining the insoluble with nitro-glycerine, or could without independent experiment and research have foretold the possibility of doing so, and I think that the patentee confined his invention to the manufacture from the soluble form deliberately and intentionally. At the date of the patent neither the patentee nor anyone else could have predicted that the insoluble form could be utilised for the purpose of making the product the subject of the patent or any such product; still less that the insoluble could be used for any such process as that described in the patent. The patentee might well shrink from facing the problem of trying to get the solution of the insoluble with nitro-glycerine, in which it was practically wholly insoluble. He might well shrink from trying to use the

highly-explosive gun-cotton instead of the comparatively safe collodion cotton, especially when he considered the danger of the mixture of nitro-glycerine and gun-cotton being rolled by the heated rollers employed in his process. At any rate, in my opinion, the patentee intended to leave it open, as uncovered by his patent, to anyone who should be able to do so, to discover a means of making a powder by using gun-cotton with nitro-glycerine, and to patent this further discovery, and the plaintiff cannot be heard to say that Mr. Nobel's invention covered or was intended to cover such further discovery. If Mr. Nobel had claimed the use of the insoluble as well as the soluble, his patent might have been held invalid, for it might have turned out that the insoluble could not be effectively or usefully employed. He has not claimed it, and thereby he made his patent safe. But he cannot now be heard to say that a limitation carefully put by him to his claim ought now to be disregarded in his favour so as to make his patent extend to that which at its date he did not claim or dare to claim. One chemical problem he solved, and he has obtained all the advantage appertaining thereto which he can legitimately claim. A further and distinct problem he left unsolved, and he ought not to be allowed to take away from the person or persons who ultimately solved it the benefit of their success. Nor is his position altered by his now discovering by experiment that he could have used his process, or some process akin to it, with the insoluble as well as with the soluble form of nitro-cellulose, so that if he had only known of it at the time of his specification he might have extended his discovery and claimed more than he did. This being the construction I give to the specification and claim of the patentee, I have now to consider first whether the patent is valid, and secondly, if it be so, whether the defendants have infringed. In my opinion, upon the construction I give to it the patent is valid. The invention was useful and very meritorious, and formed the

proper subject of a patent. And, in my opinion, if the claim be treated as limited in the way I have mentioned, the specification was sufficient and free from objection. Now, was it anticipated? The only alleged anticipation that I think it necessary to say a few words about is Mr. Nobel's own patent of 1875 for blasting gelatine, above referred to. That was undoubtedly a very important invention. Thereby, for the first time in the history of explosives, nitro-glycerine was mixed with nitro-cellulose so as to form a new solid or quasi-solid product possessing the force of the nitro-glycerine from which it was made, and yet freed to a great extent, by reason of its solid or quasi-solid form, from the insecurity attaching to the nitro-glycerine in its previously known forms. The patentee's discovery was that by taking a small proportion (about 7 or 8 per cent) of soluble nitro-cellulose and mixing it with nitro-glycerine you could obtain a solid jelly which can be used with comparative safety for blasting purposes, and that discovery in effect he patented. Now it may be said that from this great discovery it required no appreciative step or invention to arrive at the conclusion that by increasing the proportion of the soluble nitro-cellulose used you would obtain a more solid substance—that is to say, one of a horny character—which could obviously be used as a powder for propulsive purposes, and that, therefore, there was no patentable invention in Mr. Nobel's discovery, the subject of his 1888 patent. But the answer to this lies in the well-known fact that the results of combining two or more chemical substances in different proportions or by different methods may vary greatly, and that it is impossible to predicate with any certainty, or without experiment and research, from one result of combining two or more substances in certain proportions what will be the result of combining them in different proportions or by a different method. Mr. Nobel's patent of 1875 still left it open to anyone to discover, if he could, that the effect of mixing nitro-glycerine and soluble

nitro-cellulose in substantially different proportions was to produce a substantially different material, and that is what Mr. Nobel did, for his discovery patented by the 1888 patent was that by combining them by a certain method in any proportions between two parts of the one, to one of the other you could produce a hardish substance capable of being cut up and used as a propulsive powder. On this ground I think the patent of 1888 was not anticipated by the patent of 1875. But when I have to consider the question of infringement then I must apply as against Mr. Nobel the reasoning that I have just applied in his favour, and I must point out as against him that because he discovered he could make a new substance by using nitro-cellulose, of which a small part was insoluble in ether-alcohol and nitro-glycerine, it by no means followed that the same or a similar substance could be obtained by using in the place of the soluble the insoluble, in which only a small part was soluble in ether-alcohol and nitro-glycerine. The soluble and insoluble are, in my opinion, distinct substances, having, as I pointed out above, distinct properties, and the insoluble cannot, for the purposes of the plaintiff's patent, be regarded as merely the chemical equivalent of the soluble. The plaintiff's patent and claim show that he regarded the two as distinct for the purposes of his invention. This brings me to the question of infringement. And, as to this, I have come to the conclusion that there is no infringement. Several cases were cited to show the canons of construction on which the Courts have acted in different cases relating to infringement. But it is not necessary for me to deal with these cases in detail. For I desire emphatically to state that in my view one principle only governs all the cases, whether they relate to so-called matter patents or to patents dealing with discoveries, in matters of principle, or to any other kind of patent. And that principle is this. In order to make out infringement it must be established to the satisfaction of the Court that the alleged infringer, dealing with what he is

doing as a matter of substance, is taking the invention claimed by the patent. Not the invention which the patentee might have claimed if he had been well advised as holder, but that which he has, in fact and substance claimed on a fair construction of the specification. Now, I have already pointed out what the patentee in the present case has claimed. All that I need do, therefore, is to consider what is the cordite that is alleged to be an infringement, and how it is made. Cordite is made according to a patented invention of Professor Dewar and Sir Frederick Abel. I am not concerned directly with the question as to the validity of that patent, but I think it right to state that in my opinion the patentees have arrived at the discovery of cordite only after a long period of necessary experiment and research. In fact, they have solved the problem which Mr. Nobel left unsolved—that is to say, how to make a good powder out of insoluble nitro-cellulose and nitro-glycerine. Cordite is made out of those substances, and not, therefore, out of the substances referred to in Mr. Nobel's patent as those from which alone his product, ballistite, was to be made. It is made by a process which, though in some ways similar, is not identical with the process of Mr. Nobel. Cordite itself, as an explosive, is not in its qualities identical with ballistite, though it has considerable resemblance to it. Whether or not, regarded as a chemical product in its chemical constitution, cordite is essentially different from ballistite, I cannot be sure, seeing how the eminent experts before me differ on the point. But in any case, in my opinion, cordite and its manufacture are not in substance or form covered by the claim made by Mr. Nobel in his specification fairly considered. As I have pointed out, Mr. Nobel's claim is expressly limited to the use of soluble nitro-cellulose. It is not a claim for a horny or semi-horny explosive susceptible of granulation, however made so long as it is made out of nitro-glycerine, or even so long as it is made out of a mixture of nitro-glycerine and every

kind of nitro-cellulose. And to hold that Mr. Nobel's claim covers cordite and its manufacture would be, in my opinion, to unfairly extend his claim and invention, and make him the inventor and patentee of that which he never invented or patented. Sir Frederick Abel and Professor Dewar have not, in my judgment, been employing Mr. Nobel's invention or merely colourably using the insoluble nitro-cellulose as and for the soluble. As I have before mentioned, the insoluble cannot be regarded as in any true sense the equivalent of the soluble. Nor does the fact that the insoluble contains a small percentage of soluble assist the plaintiffs. When Mr. Nobel in his specification in effect put aside the insoluble as being outside his invention he knew that it contained, as commercially made and used, some soluble. And in making cordite the Government are using a gun-cotton which they have manufactured for many years past, and which contains rather less than more of the usual percentage of soluble, and the percentage of soluble contained in it is of no use for the purpose of making cordite, but rather a hindrance. The Government in making their cordite are not employing gun-cotton because it contains the soluble, but despite that fact. For these reasons I think there is no infringement and that the action fails."

APPENDIX II

(*See page* 150)

EARLY DAYS AT THE ARDEER FACTORY

(Special note by courtesy of Imperial Chemical Industries Limited)

By the time Alfred Nobel came to Britain in search of capital, the manufacture of nitro-glycerine appears to have achieved a very bad reputation in administrative circles. In the light of fifty years of experience, the marvel is that the reputation it bore was not even worse. Nobel's "blasting oil" had been by that time the cause of many disasters, including the destruction of a ship which was conveying a cargo of it abroad. (Who amongst present-day high explosives chemists would care to be responsible for the shipment of such an N/G cargo from Germany to South America ?) Nobel found in Scotland the support he required for establishing the nitro-glycerine explosives industry in Britain, Glasgow men putting up the capital of the first Company.

The site at Ardeer, chosen by Nobel himself, need not be described here. It is sufficient to say that it has proved ideal for the purpose, enjoying the advantages of wharfage for sea-going vessels, and direct connection with two important railway systems. Those special advantages were very much "in the future," however, at the time when, the plans of the Factory having been completed under the supervision of Nobel and his friend Alarik Liedbeck, the first brick of the Factory was laid in 1871. Associated closely with the constructional work as engineer was Captain Tupman, who, later, entered the service of the Company after the completion

of the Factory; and one of the bricklayers engaged in the work of construction, William Gallacher, who also was taken over by the Company with the completed Factory, was still in 1923 in the service of the Company at Ardeer Factory as foreman bricklayer. The site, as at the date of the first planning of the Factory, may be put as extending to about one hundred acres. Remotely set amidst the wide tract of sand-dunes that lies north of the River Garnock along the sea-front, it was an establishment which could always be sure of plenty of "elbow-room," and, in view of the expansion brought about in the course of the years, that was quite a fortunate matter.

The work of construction occupied about two years. On the 13th January, 1873, the first charge of nitro-glycerine was made at the factory, and an organisation destined to become the greatest of its kind in the world entered the new industry. The industry as such was then about six years old. From a world-output of eleven tons of dynamite in 1867, production had risen to 1,350 tons in 1872. It will be seen, therefore, how quickly nitro-glycerine as a blasting agent, in the form of dynamite, was shedding the stigma brought upon the explosive by its premature use in the form of "blasting oil." The value of dynamite was being rapidly and widely recognised, the demand was insistent and growing, and the price obtained for the product was certainly substantial, when the first contribution of the Ardeer Factory was successfully made under the management of Mr. McRoberts.

From the very outset, the spirit of Research seems to have settled over the Ardeer Factory. Improvement—experiment—improvement—the work of production and the search for better methods of production going on together—so the life of the Factory has continued. Associated with Mr. McRoberts in the production of that first charge of nitro-glycerine fifty years ago was one Factory notable—William MacDonald—whose personal recollec-

tions of experiments made and mooted are happily still available, and testify most eloquently to the courage and enthusiasm which directed them. Nowhere in the world, in fact, has a producing organisation connected with the industry appeared to reflect so clearly the spirit of the founder than the Ardeer Factory has done from its very earliest days. It has never resigned itself to contentment with mere production.

The new Factory in some respects made large demands upon the enthusiasm of those men who constituted the first staff. Its remoteness was a tremendous point in its favour in the eyes of the nervous public, and its isolation had advantages which do not require to be enumerated; but if there be one picture more than any other which one would desire to have placed before the people who promenade in leisurely manner from the railway platform in the Factory to their various departments, in these days, it is that of the stream of workers in mid-winter, trickling up through Ardeer Square and by miserable by-paths to that first factory, fifty years ago. There was no road to the Factory then. Anything big in the way of plant came up, by favour of Merry & Cunninghame, on their line to the nearest point to the Factory. Yet the new venture throve exceedingly.

Let us survey the busy little centre one year after its establishment. With the others, we shall drift up through Ardeer Square, and, leaving that more or less worthy evidence of settled civilization behind us, strike out on the lonely track over the dunes to the Factory, feeling as did those who had not yet become too familiar with the ways of dynamite. It is early morning, rather dark. The night-watchman is just coming off duty. The Staff are early on the scene. Mr. McRoberts, the Manager; Captain Tupman, Construction Manager; Messrs. Donald and Kater, Chemists, assistants to Mr. McRoberts; Mr. David Martin, draughtsman; and Mr. John Goldie, ex-warrant officer, Royal Navy, and now

time-keeper. The Construction Manager has directions to issue to the tradesmen, and he and the draughtsman are soon in consultation with their men. There is no anxiety about steam, for the single boiler and the solitary engine are in good hands. The engineman proves quite a fitter, too, when occasion demands. Foreman George Weir marches off his labour squad of four to meet Conn, the railway carrier, who is expected up from the railway station with a consignment of general stuff, but especially with the cases for the day's output. The cases are made in Glasgow by Alexander & Company, and Anderson and Henderson. The labour squad meets, on its way towards the cart-track, an " orra man " with a contraption evidently designed for the carrying of water. He is the Water Commissioner. There is no drinking water in the Factory, and it is the duty of this important functionary to convey down to the Ardeer Ironworks each morning four casks, fill these with water, and bring them back to the factory. He is to his mates a subject of jest, and the recipient of countless agreeable suggestions, this Pussyfoot of 1874! The labour squad finds Conn just where expected—stuck with his cart in the hopeless ruts of a hopeless track. We shall leave them there, extricating Conn from his difficulties. Returning to the administrative centre, we find it to be also the research centre, the test centre, the experimental centre, and the whole general headquarters in one. Mr. McRoberts is here, in a corner of this laboratory, dealing with the whole correspondence of the Factory, writing the replies himself. Mr. Donald is wrestling with some technical problem. Mr. Kater's place is vacant. He is out on the plant. Mr. McRoberts, delving into the correspondence, his mind full of experiments and plant development, is vowing that he must have a clerk for office work (within a year or so he had a clerk, who did the time-keeping also and thus relieved Mr. Goldie for duty as magazine-keeper). The correspondence over, Mr. MacRoberts sets

out for the plant, and we accompany him. It is an interesting round. You gather in the course of it that the total number of workers in the Factory is about seventy or eighty. The "hill" is doing two charges of N/G per day; usually about ten charges per week. There is no work done on Saturdays. Occasionally, the magazine accommodation being small, the whole Factory "knocks off" work for a time. It is a leisurely life, on the whole. At one point may be seen a queue of about thirty girls, each with a box full of cartridges, lined up at a packing house. There are no runners to take cartridges from the huts to the packing house. Each hut worker, when her cartridge box is filled, carries it along to the packing house, where the cartridges are weighed by the foreman; and off goes the hut-girl to continue the work. It will be noted that some of the girls are barefoot. Well, the sand is soft and easy to the feet! There are no floors in the houses. Sand floors in the "hill" houses, the dynamite mixing house, the huts and the packing houses! No donning of rubber shoes. Later on, we shall take part in what is an "occasion" at the Factory—the loading of a steamer. The "hill" will be stopped, that day, for the steamer will be loaded from small boats, and the hillmen, who are all seamen, will be required to manage the boats. The girls will be there, too. The cargo will be run on bogies to the loading-bank, transferred there by the girls to bogies on a light line running down to the sea, received at the water-edge by men standing waist-deep, and placed in the small boats for transfer to the steamer. We will learn that it is a very difficult matter to get any steamer to take such a cargo. Shipowners are shy: insurance is high; and the explosive cannot be conveyed by rail, that being contrary to law.

Returning to general headquarters, we find another aspect of the transport question worrying the Manager. He is concerned as to the whereabouts of a Factory outfit—horse-drawn vehicle

and its responsible attendant—engaged in the distribution by road of the Factory product. Long and lonely are the journeys which have to be undertaken in this connection; many and varied and troublesome are the difficulties which have to be met by the man in charge. He is avoided by his fellows when his load is identified. He must be resourceful in description and bland of speech, when asked by suspicious owners of hostelries as to the nature of the load he is escorting, and must, by the magic of easy phrase, change dynamite to grand pianos or hog lard, as he may think fit. Otherwise, the kindly stars or the driving blizzard, and the shelterless night may be his portion, for the man with the cartload of dynamite is the Ishmael of the King's Highway.

With these fleeting glimpses of the very early days of the organisation still in mind, it is interesting to note how speedily the spirit of self-dependence manifested itself at the young Factory. By 1875, water had been led in, and a gas-work had been completed at the Factory, which had already grown considerably.

Shortly after that, when pride of place as a blasting agent had been secured by dynamite, and the position of guncotton had not been quite determined, the first nitro-cotton was made at the Ardeer Factory. Nobel had discovered blasting gelatine, but it had not been made in Britain. The Ardeer Factory's interest in nitro-cotton was ahead of its equipment then, for the machine used in squeezing the water and acid from the stuff was a common domestic wringer. In 1877, the first blasting gelatine made in this country was made at Ardeer. This was an experimental lot. Mr. Kater, the last of the high-explosives chemists of that day now with us, recalls that methylated spirit was used to make the cotton more soluble. The blasting gelatine was too thin for cartridges, but good use of it was made in the immediate neighbourhood of the Factory; it was given to Messrs. Merry & Cunninghame to blow out one of the "salamanders"—furnace bottoms—at the

ironworks, for which purpose it proved thoroughly successful.

Although Nobel's discovery of blasting gelatine was made at the end of 1875, and rapid progress with its manufacture was being recorded on the Continent immediately thereafter, it was still being imported to Britain in 1878. Following the manufacture of blasting gelatine experimentally at Ardeer in 1877, as referred to, there was further manufacture in 1879, and manufacture on a large scale was begun in 1881, only to be suspended in 1882, as the conditions laid down by the Home Office could not be met by the manufacturers. Thus the position remained until 1884, when manufacture was resumed.

The plant for making soluble nitro-cotton was introduced at the Factory in 1881.

The period from 1887 till 1897 witnessed tremendous developments at the Factory. During that time there arose around the original factory a group of large establishments—each in itself a considerable factory—which are included in the Ardeer Factory of to-day.

The section devoted to the manufacture of nitrate of lead was started up in 1887, a year rendered quite noteworthy by the fact that the branch line from the Glasgow and South-Western Railway to the Factory was then made.

In 1888 Nobel invented Ballistite, and in 1890 the manufacture of Ballistite was begun at Ardeer.

Independence of outside case-makers had by that time become a necessity, and in 1890 the Box-making Department at the Factory was opened.

The manufacture of guncotton on a large scale was started at the Factory in 1892, in which year, also, the output of Chilworth Paste from Ardeer began.

The Cordite Department at Ardeer began operations in 1895.

The Glycerine Department came into being in 1896.

In December, 1896, the first factory train for workers came up from the main line.

It will be seen that the growth of the industry followed the lines of self-dependence; that the excellence of the producing conditions at Ardeer, with its fine site, had been fully recognised. There had been developments in the directing organisation, too. The original British Dynamite Trust had given place to Nobel's Explosives Company, Limited, the organisation acquiring much strength in the process.

APPENDIX III

(*See page* 78)

FIRST SWEDISH PATENT

No. 1261. Stockholm, 6th October, 1863.

Patent for the period of ten years in favour of Alfred Bernhard Nobel in respect of a method discovered by him for making powder.

HIS ROYAL MAJESTY and the Royal Board of Trade hereby declare :

"Alfred Bernhard Nobel has applied to the Royal Board for a Patent in respect of a process discovered by him for manufacturing powder both for shooting and blasting purposes, of which discovery the applicant gives the following description :

"The invention is based upon the following principles : (1) The production of such modifications in the explosive action of various substances that by means of a slower process of combustion they may be used for shooting without thereby damaging the weapons. (2) Suitable methods of heating such substances as can be caused to explode only at high temperatures, there being a large quantity of such substances, *e.g.*, nitro-glycerine, the ethyl and methyl nitrates, etc.

"I use nitro-glycerine chiefly which is produced by slowly adding glycerine to a mixture of sulphuric and nitric acid.

"During the process of making such nitro-glycerine, or when it is made, I add ordinary powder as powder absorbs it, whereby the results referred to above are obtained, viz., the force of the explosion is lessened, and the nitro-glycerine is heated by the powder gases to the temperature at which it will explode. The powder thus prepared has the following qualities :

"1. In appearance it is similar to ordinary powder.

"2. It is considerably more powerful.

"3. It leaves less deposit and fouling matter than ordinary powder.

"4. The rate of combustion is somewhat slower than in the case of ordinary powder, more particularly when I am aiming at attaining this result, I temper the powder with other unexplosive substances, especially with oils which fill up its pores.

"It is clear that, apart from ordinary powders, there are many substances and mixtures which serve to heat nitro-glycerine while lessening the rapidity of the explosive process, such as guncotton, etc.; we are, however, new to the technical use of such substances, which is only practicable through dividing them up very finely."

"As a result of this application, and in accordance with His Royal Majesty's gracious Order regarding the patent on the 19th August, 1856, the Royal Board has decided to grant Alfred Bernhard Nobel a patent for the period of ten years for making powder in the manner described above, providing that the applicant shall have the right during the period in question, to the exclusion of all other persons, to exploit this invention throughout the kingdom, alone or through others authorised by him, provided that the applicant observes the regulations in force regarding the manufacture and sale of goods, but without any obligation upon the patentee to quality as a Master, or to acquire rights of citizenship (Bürgerrecht).

"Finally the Royal Board has to state that these letters patent do not constitute any guarantee that the invention is new, or that its exploitation may be profitable."

Stockholm, the 14th October, 1863.

F. Akerman.

C. F. af Ström. J. U. Grönland. G. Hegardt

L. S.

W. Slifversparre.

APPENDIX IV

(*See page* 78)

CROSS-EXAMINATION OF ALFRED NOBEL ON THE SUBJECT OF HIS FIRST EXPERIMENTS WITH NITRO-GLYCERINE AND DYNAMITE

Question 1: Where do you now reside?

Answer: 53, Avenue Malakoff, Paris.

Question 2: Give full name of some judicial local officer, such as a judge or Notary Public, or of some intelligent and respectable private person, residing near you, to whom a commission can be given to take testimony?

Answer: The United States Consul in Paris. I do not know him personally, but I assume that does not matter.

Question 3: Do you know of anyone before you having experimented with nitro-glycerine? Give full description of what you know on that subject.

Answer: Yes. Sobrero, who discovered it, also discovered that it was explosive. Professor Sinin and Professor Trapp in St. Petersburg went a step further in conjecturing that it might be made useful and called the attention of my father to it, who was then engaged in making torpedoes for the Russian Government during the Crimean War. My father tried it, but could not get it to explode. Some years later, I think in the beginning of 1862, he took up the matter again, and then began to mix nitro-glycerine with gunpowder. He thus succeeded in obtaining a detonating powder which he offered through me to the Russian Government, but he soon found that after some hours keeping it had lost its

detonating property. After vain efforts to overcome that evil, he gave up the nitro-glycerine powder, and sent as a substitute to St. Petersburg chlorate of potash powder, which the Russian Government declined to make use of.

The cause of my father's non-success was this: Believing nitro-glycerine to be several hundred times stronger than gunpowder, and believing also that it must always remain a very expensive article, he looked on an addition of 10 parts by weight of nitro-glycerine to 90 parts of powder as the utmost practical limit. That mixture detonated when just made, because the exploding powder then acts on a bulk of liquid nitro-glycerine, but after an hour or two the nitro-glycerine becomes absorbed in the pores of the gunpowder used in the mixture, and then instead of detonating as before, burns more slowly than ordinary powder.

It is true that it can be made to detonate by the influence of a strong detonator cap, but it should be borne in mind that my father, when he experimented, could not resort to that mode of ignition, which is a later invention of mine.

Seeing that the powder produced by my father, so far from detonating, was very slow in its action, I suggested to him to use it for guns, and we both experimented with it for that purpose.

It was, I believe, in the autumn of 1863 that my father got the new powder tried in the fortress of Carlsborg in Sweden before a Military Commission. It did tolerably well in heavy guns, but he utterly failed to burst a shell which he repeatedly charged with it. I then took the matter in hand, charged a shell with about 50 per cent of very hard pressed non-porous gunpowder and 50 per cent of liquid nitro-glycerine, and exploded the same in presence of the above-mentioned Military Commission. Since the time of that experiment every real improvement that I know of relating to nitro-glycerine has been made by me without any other than mere mechanical assistance of other parties.

Question 4: When did you first experiment with nitro-glycerine, and what did you do?

Answer: The first time I saw nitro-glycerine was in the beginning of the Crimean War. Professor Sinin in St. Petersburg exhibited some to my father and me, and struck some on an anvil to show that only the part touched by the hammer exploded without spreading. His opinion was that it might become a useful substance for military purposes, if only a practical means could be devised to explode it. I was very young then, but it much interested me. My first experiments with nitro-glycerine for a purpose were in the early part of 1862, after having received information from my father that he had got gunpowder and nitro-glycerine mixed together to explode. The first time I successfully detonated nitro-glycerine was in May or June, 1862. It took place in a canal or dyke in my brother Lewis Nobel's engineering establishment at St. Petersburg. My brothers Lewis and Robert Nobel were present. I filled a glass tube with nitro-glycerine and corked it well. I inserted that tube into a tin tube which I filled with gunpowder and corked, first letting a fuse into the powder. I set fire to the fuse and thrust the whole into the water. A very sharp shaking of the ground and a spout proved that the nitro-glycerine had exploded as well as the powder.

Question 5: At that time what was known as to the means of exploding it?

Answer: Nothing that I know of except that it exploded under the blow of a hammer, producing nothing but a local explosion; and, further, that my father had succeeded in getting a mixture of 10 per cent of nitro-glycerine and 90 per cent of gunpowder to detonate, if used forthwith, whilst it had lost that property after one or two hours keeping.

Question 6: Had it been exploded in mass, in quantity, otherwise than by accident, while being made—if so, how?

Answer: Not that I know of. My father tried to explode it during the Crimean War, but completely failed to do so. My father's later experiments with gunpowder mixed with nitro-glycerine were all on a small scale.

Question 7: Had it been heated up to the point of explosion—360 more or less—if so, how, by whom, and when and where?

Answer: Not to my knowledge.

Question 8: Had it been exploded by percussion or concussion—by striking or otherwise, in a body; if so, where and when, and how, and by whom?

Answer: Not that I know of, except by accidents which have, I believe, taken place in chemical laboratories.

Question 9: Who first mixed gunpowder with nitro-glycerine—when, where, how? Give all the details.

Answer: My father in the beginning of 1862, when he mixed 10 per cent of nitro-glycerine and 90 per cent of gunpowder, but the mixture detonated only a few hours after it was made, as the nitro-glycerine got absorbed by degrees into the pores of the powder and then ceased to detonate. He gave it up, and took to chlorate of potash powder for blasting purposes.

Question 10: Was the powder pulverised—if so, when, where, and by whom?

Answer: To my knowledge I was the first who mixed pulverised powder with nitro-glycerine. It was 70 per cent of powder and 30 per cent of nitro-glycerine, being rather wet in appearance. It was before I invented the ignition of nitro-glycerine and nitro-glycerine compounds by local detonation. I do not closely remember the date, but it was in the latter part of 1863. I tried a cartridge in granite, but found the combustion slow and incomplete. It would have been a perfect success if at the time I had had the detonating ignition.

Question 11: Was his mixture patented? If so, by whom, when and where?

Answer: The mixture of powder with nitro-glycerine was patented by me in France, England, Sweden and Belgium in 1863. Although my father had first hit on mixing nitro-glycerine with gunpowder, he considered on account of his non-success, the invention as mine, and desired me to patent it in my own name, which I did. My patents of 1863 do not mention that the powder should be pulverised, because at that time I had not yet invented the ignition by means of a local detonation and because a mixture of pulverised powder and nitro-glycerine only becomes a valuable blasting agent when used with that ignition.

But by Letters Patent, taken by me in France in January, 1864, I claimed nitro-glycerine absorbed in porous substances in general, which of course includes porous gunpowder as well, since I had previously patented in 1863 the use of nitro-glycerine absorbed in porous gunpowder.

Question 12: Was this mixture used in blasting? If so, by whom, where and to what extent? And how and what were the proportions? (N.B.—See my English and French patents.)

Answer: This mixture of pulverised powder and nitro-glycerine was pushed for a time by Mr. Wasserfuhr, powder manufacturer at Cologne, Prussia, in 1868 or 1869, but was speedily given up because it could not sustain the competition of other nitro-glycerine compounds. I myself never recommended it for blasting, but another compound, which is substantially the same, and has the same strength, but is safer to manufacture, to carry, to store and to use. That compound, broadly described, is nitro-glycerine 20 parts, mixed with 80 parts of gunpowder, less sulphur. That article was first patented by me in . . . . the year . . . . and has been largely sold from my various factories. The mixture of gunpowder and nitro-glycerine has no advantage over that com-

pound, but is as I have stated, much less safe; the only reason why I have not used it is my having something better to resort to, which is proved by the fact that its use has died out in Prussia, where Mr. Wasserfuhr, as I have mentioned, tried to introduce it.

Question 13: How was it exploded?

Answer: Since I invented the ignition by detonation or local explosion, I do not think it has been exploded in any other way.

Question 14: When did you discover the mode of exploding nitro-glycerine by detonation? How did it occur? Give the several steps in its progress, and where and all the circumstances.

Answer: I had the crude idea in my head long before, but it was in Stockholm in October or November, 1863, that I first succeeded in exploding nitro-glycerine by means of a local explosion. I had many failures, until my father and brother, who witnessed them, rather ridiculed my tenacity. I proceeded thus. In a vessel, containing nitro-glycerine, I inserted a small glass tube, charged with gunpowder and connected with a fuse. I fired the latter, and much to my surprise, the powder, time after time, went off without firing the nitro-glycerine. At last I discovered the cause of my non-success; the powder had not been sufficiently confined and had not burst the glass tube. I then secured well with sealing wax the ends of the latter and the first trial proved a complete success. I then at once bethought myself of the best means of practically applying my invention, and the means now largely in use, viz., the ignition of nitro-glycerine through a small gunpowder charge, as well as by a detonator cap, containing a strong charge of fulminate, into which a fuse inserted, were patented by me in the beginning of 1864. My first step, as I have mentioned, was to explode a small charge of gunpowder contained in a glass tube swimming in nitro-glycerine. My next step was to use a small wooden cylinder having a fuse in one end and a gunpowder charge in the other, the latter secured by a cork. The wooden cylinder

was let down in the nitro-glycerine to be exploded, the fuse fired, and the nitro-glycerine went off. The next step was the detonator cap now so largely used for dynamite. I had some trouble to get strong caps, so that I could not introduce that system commercially until the year 1865, when I resided in Hamburg. The powder ignition, which I have here described, I applied in Sweden in 1864, especially in quarries at Stockholm and in the mines of Ammerberg in Sweden, belonging to the Vieille Montagne Belgian Company. Before I invented the detonating ignition by small powder charge or detonator cap, I applied nitro-glycerine to blasting by mixing very hard grained non-porous gunpowder with about its weight of nitro-glycerine in cartridge. I also used nitro-glycerine in tubes with a gunpowder charge around. Experiments which were made very successfully in the mines of Ammerberg in the latter part of 1863 (I think November) are described in Dingler's Journal for that period.

Question 15: If anyone or more persons aided you, give their names and present place of residence, and what they did.

Answer: What my father did, I have already stated. I had no essential aid from anyone else, except from Mr. Theodor Winckler (now defunct), who was useful to me in directing me how to get strong caps suited for my purpose, manufactured on a commercial scale.

Question 16: When, where and in what manner was this method first used in practical operations?

Answer: The detonating mixture of nitro-glycerine and gunpowder was first technically applied for blasting rock by me in the mines of Ammerberg towards the end of 1863. The ignition, by local explosion of gunpowder contained in a glass tube, was first applied for blasting purposes by me in a cutting of a railway near Stockholm, of which Captain Nordenfelt had the charge. The next application was in the quarry of Tyskbagarebergen at Stock-

holm. The first commercial application of the detonator cap was, I think, in a quarry belonging to the Mansfield Silver and Copper Mining Company at Eisleben in Germany. All these methods were used from the beginning substantially as they are now used.

Question 17: What is dynamite?

Answer: I have given the name of dynamite to any substance having the appearance of a solid substance and having nitro-glycerine in its composition.

Question 18: When did you invent it and where?

Answer: As far back as in 1863 I foresaw the drawbacks of the liquid form of nitro-glycerine, and experimented with its absorption, especially in porous charcoal, but also in sawdust and in guncotton. Already in January, 1864, my patent for France claims broadly nitro-glycerine absorbed in charcoal or other porous substances. Still liquid nitro-glycerine held its own as a blasting agent until the latter part of 1866, when some accidents to which its carriage gave rise induced me to take up dynamite again and push it commercially. Hence I began to perfect it, experimenting a good deal at the factory called Krümmel and belonging to my Hamburg firm, Alfred Nobel & Co. I tried several absorbents, but chiefly charcoal and porous-silica, the great absorbent power of which I had had frequent occasion to observe as I used it to pack the nitro-glycerine tins in. I very soon, however, fixed on the silica or kieselguhr, and then turned my attention to the detonator caps, which were required of greater strength for dynamite than for liquid nitro-glycerine. This done, I gave my partner, Mr. Th. Winckler, two kinds of dynamite, viz., one containing 75 parts nitro-glycerine and 25 parts porous silica, the other containing 66⅔ parts nitro-glycerine and 33⅓ parts porous silica, requesting him to proceed to the mine of Konigsgrube in Silesia to test their practical value. He reported that the latter substance was generally preferred, being more handy and fully strong enough.

I wrote again strongly advocating the dynamite containing 75 per cent of nitro-glycerine (the one now so largely used), but the miners expressed themselves stronger and stronger in favour of the weaker dynamite. I yielded reluctantly, and the dynamite containing only 66⅔ per cent nitro-glycerine was offered for sale by my Hamburg firm. Then came numerous complaints from the mines, and I proceeded myself—I think it was in the beginning of 1867—to the mines of Dortmund to set matters right. I remained there five or six weeks and experimented with the dynamite containing 75 per cent of nitro-glycerine and 25 per cent of porous silica, which I then converted into cartridges as better suited to the miners than loose dynamite, and recommended it in that shape for sale. It grew into favour and is now a great article of commerce, known here as dynamite and in America as giant powder. I also manufacture and sell various other kinds of dynamite, containing substantially the ingredients of gunpowder, less sulphur and plus nitro-glycerine. Some contain nitrate of soda instead of nitrate of potash, others sawdust, rosin, paraffin, or coal dust instead of charcoal; but those are variations which do not substantially alter the burning process from which gunpowder derives its power. Sulphur is added to powder merely to quicken its combustion; when the powder contains nitro-glycerine, sulphur becomes useless, and it is therefore an improvement to leave it out.

Question 19: Did anyone aid you in making experiments, and if so, who, where, when, how?

Answer: A workman called Schnell engaged at the works at Krümmel, belonging to Alfred Nobel & Co., at Hamburg, frequently assisted me in mixing charcoal or guhr with nitro-glycerine. But it was only mechanical aid, which any other workman might have done.

APPENDIX V

(*See page* 78)

EXTRACT FROM THE PROCEEDINGS IN THE EXAMINATION OF WITNESSES HELD IN THE PRESENCE OF JAMES H. ANDERSON, UNITED STATES CONSUL AT HAMBURG, FROM 22ND TO 26TH JANUARY, 1866, REGARDING J. P. SHAFFNER'S OBJECTION TO ALFRED NOBEL'S APPLICATION FOR A PATENT IN THE U.S.A. FOR SUBSTITUTES FOR GUNPOWDER, ETC.

The witness, Peher Wilhelm Jansson, of Sweden, aged 35, made the following statement after taking the oath.

Question 1: Name and address ?

Answer: Peher Wilhelm Jansson, resident at Isasen, Lerbäck Commune, Orebro district.

Question 2: Did you witness the experiments carried out with Nobel's nitro-glycerine in the Ammerberg mines in Sweden, and when did you see the first experiment ?

Answer: I was present in the Ammerberg mine in December, 1863, when experiments were carried out with Nobel's nitroglycerine; these experiments were the first at which I was present.

Question 3: Were any other persons present ?

Answer: About twenty other persons.

Question 4: Did Nobel carry out any other experiments with nitro-glycerine in your presence at a later date, and was his method then improved ?

Answer: Herr Nobel carried out two further experiments in my presence at a later date, and his methods were gradually

improved. Nitro-glycerine is an oily liquid; I do not know its composition. It is used in the following way: A hole is bored in the rock and filled with nitro-glycerine. It is caused to explode by lighting a fuse, whereupon the rock bursts. I am familiar with powder blasting, and the effect of nitro-glycerine is about twice as powerful. I am a miner by trade.

The testimony of Anders August Andersson, of Lerbäck, was to the same effect. He stated that the first experiment at Ammerberg had been carried out on the 17th and 18th December, 1863.

The witness, Captain Carl Wennerström, aged 45 years, made the following statement:

Question: What do you know of the matter?

Answer: I was present at Mr. Nobel's experiments of the autumn of 1863. At the beginning of 1864 I received some nitro-glycerine from Mr. Nobel, and from that time to the present I have constantly used nitro-glycerine in blasting operations in mines. I always got it from Mr. Nobel, until 1864, when a company acquired Nobel's patent and proceeded to manufacture the substance. I was and am manager of that company. To my knowledge, nobody other than Mr. Nobel has ever been regarded as the inventor in Sweden. Mr. Nobel has improved his invention in the course of time.

Cross-examination of Colonel Shaffner with Mr. Alfred Nobel, Hamburg, aged 32 years.

Question 1: Will you tell me the precise date on which you succeeded in causing nitro-glycerine to explode in the manner described in your American patent?

Answer: The first idea goes back a long way, as is the case in the germination of most useful inventions; but I achieved my first success in experiments in causing nitro-glycerine to explode

on a practical scale at the beginning of the summer of 1863 (whether in May or in June, I cannot definitely remember). The nitro-glycerine exploded under water in the presence of my brothers Robert and Ludwig.

Question 2: Where and in what circumstances did you hit on the idea?

Answer: Sinin, Professor of Chemistry in St. Petersburg, called the attention of my father and myself to this substance many years ago. He demonstrated its extraordinary powers by causing a few drops of nitro-glycerine to explode on an anvil, showing at the same time that the explosion was limited to that part which the hammer struck. He said that nobody had yet succeeded in making nitro-glycerine usable in practice, adding that it would be an achievement of the first importance if nitro-glycerine could be produced in some convenient way, and especially if it could be caused to explode in greater amounts. This occurred, I believe, twelve or more years ago. Since then the matter has never left my mind, but I have always been thinking of it with a view to future experiments. As my father invented and manufactured submarine mines, it was only natural that I should become interested in explosives, as indeed I did.

Question 3: What were your first experiments? Please describe them fully and say who was present.

Answer: The first experiment in blasting operations was carried out in a quarry at Huvudsta, near Stockholm, in the presence of several workmen with a lead cartridge case, which I had with me, ready charged. Then I improved my invention, and in the autumn of 1863 it was tested by the Swedish Government with a view to ascertaining its use in shells. In December, 1863, blasting experiments were carried out in the Ammerberg mine. The success of these latter experiments is testified to by the statements of the witnesses present, and in the case of the former

by an article in the *Aftonbladet* on the 18th November, 1863. Apart from the members of the investigating committee, a large number of persons were present at this trial. At the Ammerberg operations Mr. Turby, the principal mining engineer, the engineer Beck, and a dozen workmen were present.

Question 6: How long have you been selling nitro-glycerine in Sweden, and manufacturing it for sale?

Answer: I have been selling nitro-glycerine in Sweden since the beginning of the year 1864; I cannot remember the exact month, but regular manufacture with a view to sale was not started until May or June, 1864.

Question 7: Did you yourself supervise the manufacture, and if this was the case, what assistance had you?

Answer: At first I carried out the manufacture by my own methods myself, but afterwards I had a young man called Hertzman as an assistant, and some workmen, who all lost their lives in the explosion which destroyed the laboratory on the 3rd September, 1864.

Question 8: What part of the invention in respect of which you applied for a patent can be traced to the ideas or suggestions of your father or your brothers?

Answer: My father and my brothers helped me, and they were of great assistance to me, but the best proof of the fact that they were of opinion that I was the inventor consists in the numerous patents which are in my name alone. My father tried long before me to make something of nitro-glycerine, but this invention is mine and he makes no claim to it.

(Fifty-five more questions were put, but they and the answers to them have no particular interest.)

APPENDIX VI

(*See page* 88)

DESCRIPTION OF THE MANUFACTURE OF NITRO-GLYCERINE

(ROBERT NOBEL'S MANUSCRIPT)

THE sulphuric acid used in the production of nitro-glycerine must have a specific weight of 1.845 to 1.850 ; of course the more concentrated it is the better.

The nitric acid must have a specific weight of 1.455 to 1.456, or slightly more ; it must not be fuming acid, *i.e.*, it must be free from hyponitric acid, and also free of chloride.

The glycerine must contain as little water as possible, *i.e.*, when it contains no lime it should have a specific gravity of 1.27 ; if it contains lime it should have a specific gravity of 1.28 to 1.29. Brown glycerine has practically no disadvantages.

Sulphuric and nitric acid are mixed in the proportion of 2 to 1 in weight. (In the factory the mixture of the acids is effected in glass containers, the nitric acid being poured in first, and the sulphuric acid afterwards, 67 pounds of nitric and 133 pounds of sulphuric acid in each container.) When the acids have been mixed, they are poured into jars for cooling until the temperature of the mixture is 10 to 12 degrees. If the cooling process is carried too far, the second hydrate of the sulphuric acid separates in crystals, which makes it more difficult to draw off the acids, as the crystals block the pipes.

In order that it may not be too thick, and may mix readily with the acids, the temperature of the glycerine must be 12 to 15 degrees Centigrade.

While the compound is being formed, a temperature of 46 to 47 degrees Centigrade must be maintained. The mixture begins to boil at a temperature of 57 to 60 degrees, giving off hyponitric acid in large quantities, and when this happens little or no nitro-glycerine is formed. However, the temperature at which boiling takes place is to a certain extent dependent upon the degree of concentration and the temperature of the acids and of the glycerine, the mixture boiling rather more easily if the acids or the glycerine are too warm before mixing, or if the nitric acid is fuming nitric acid. If glycerine is added in excess the mixture always begins to boil, and if too little glycerine is added, less nitro-glycerine naturally results, and the temperature of the mixture remains lower. The amount of the glycerine added should be one-sixth to one-seventh of the weight of the acid compound.

The water in which the nitro-glycerine forms must be stirred during the process, and be kept cool with ice. One and a half or two hours after the process has been completed nearly all the nitro-glycerine will have formed, and after that period any further separation will be practically negligible.

The water in which the nitro-glycerine has formed will naturally contain all the sulphuric acid that has been used, as well as the nitric acid which has not been consumed in the formation of nitro-glycerine, and some glycerine. The specific weight of the acid water may vary. When the specific weight of the liquid is 1.10 it will contain 12.24 per cent anhydrous sulphuric acid, or 15 per cent of acid hydrate; at a specific weight of 1.15 it will contain 17.14 per cent of anhydrous acid, or 21 per cent of acid hydrate; at a specific weight of 1.20 it will contain 22 per cent of anhydrous acid, or 27 per cent of acid hydrate. If the yield

is small a greater quantity of nitric acid naturally passes into the water, and the above figures require adjustment.

Since, as has been said, the yield varies, the content of nitric acid in the acid water must also vary, and the following figures will furnish a basis for computing it.

By the cold method process 1 pound of nitro-glycerine has been my greatest yield, from a mixture of 3 pounds of sulphuric acid of 1.85 specific gravity, and 1.5 pounds of nitric acid, of 1.456 specific gravity (*i.e.*, 4.5 pounds of acid mixture), together with about 60 *orts* of glycerine. Since 1 pound of nitro-glycerine, as can easily be calculated, contains 71 *orts* of anhydrous nitric acid, corresponding to 1 pound 4.9 *orts* of nitric acid having a specific gravity of 1.456, 45.1 *orts* of nitric acid must have been lost in this case. By the warm method process it is possible to obtain a yield of about 1 pound of nitro-glycerine from about 5 to 5½ pounds of acid mixture, if the acids and glycerine are of good quality.

When the nitro-glycerine has been drained off, it is first rinsed for twenty to twenty-five minutes with warm water (30 to 36 degrees centigrade), then the nitro-glycerine is left to collect, after which the water is drained off. It is then washed with a warm soda solution of about the same temperature as the water, care being taken that the cleansing process is not carried out too violently, since a strong frothy reaction is produced owing to the elimination of the carbonic acid. The washing is continued until the testing paper shows no acid reaction. When the brown washing water has settled and been poured off, the nitro-glycerine is filtered. The filters must be cleansed after being used twice. The filtering process is made much easier if the top impure layer of nitro-glycerine is separately strained through a flannel before or after the rinsing.

APPENDIX VII

(*See page* 90)

EXTRACT FROM A. NOBEL'S CORRESPONDENCE WITH O. SCHWARTZMANN, AMMERBERG

Stockholm, 2nd January, 1864.

HERRN OTTO SCHWARTZMANN,
General Manager of the Ammerberg Works.

DEAR SIR,—

While you were abroad, Herr Beck was kind enough to allow me to carry out experiments in your mines, with a powder for which I hold patents both here and abroad.

These provisional experiments seem to have proved the superior quality of the powder in question. As it is more powerful, especially having regard to the space it takes up, the amount of the charge can be lessened or greater quantities of rock can be blasted.

Its main advantage is, I believe, in the saving of labour. The measure of this advantage is difficult to determine after these incomplete experiments, and Mr. Toweley is of opinion that in order to do so, it would be necessary to use my powder exclusively in one of your open quarries. By comparing the yield with that of the previous fortnight, it would be possible to commute its effectiveness.

Would you be so kind as to grant permission that these experiments may be carried out at Ammerberg ? I am well aware that this must cause a certain amount of bother, but I also know from

Mr. Carlsund that in other Swedish mines I should meet with less goodwill and more prejudice.

As for the powder used in the experiments, I would request you to fix the price that you pay for it as you think right.

I beg to remain, etc.,

A. NOBEL.

Kindly reply to Stockholm.

Askersund and Ammerberg, 13th February, 1864.

To HERR A. NOBEL,

Civil Engineer, Stockholm.

If ever a letter has been lost, this has certainly happened to mine of the 13th January, in which I answered your valued communication of the 2nd of the same month. . . .

I replied that I should be delighted at any time to carry out experiments with your improved powder. In my opinion it would be better to carry out the experiment in the galleries, or in making a breach in solid rock rather than in the open quarries. I do not know what price I should allow you, but in any case the workmen should provisionally have the powder given them at the same price as ordinary powder, for that is the only way of ascertaining which powder he really prefers.

Hoping that my letter of the 13th January will come to light,

I beg to remain, etc.,

SCHWARTZMANN.

Askersund and Ammerberg, 28th April, 1864.

To, HERR A. NOBEL,

Civil Engineer, Stockholm.

Having heard nothing further from you since I received your valued communication of the 22nd February, I cannot refrain from repeating to you, my dear sir, that I am ready at any time to

carry out experiments of your interesting discovery. I should be particularly glad if you yourself could take part in such experiments.

I beg to remain, etc.,

SCHWARTZMANN.

Draft in Alfred Nobel's handwriting.

Stockholm, 1st May, 1864.

HERRN OTTO SCHWARTZMANN,

Ammerberg.

I have received with great pleasure yours of the 28th April, which is a further proof of your goodwill. I shall shortly be arriving at Ammerberg, when I shall ask you to forgive me for the delay. In the meantime permit me to say that I have employed the time in improving my process and making it more practicable. The result achieved is indeed almost startling.

APPENDIX VIII

(*See page* 97)

DISASTERS AT ASPINWALL, SAN FRANCISCO

To HERR ALFRED NOBEL,

820, Pine Street, New York.

San Francisco, 30th April, 1866.

In view of this second terrible disaster which has occurred at Aspinwall since my last letter on the 17th instant, we must, no doubt, give up any hope of finding a ready market for it at an early date. We received telegraphic news of the disaster from there, and this morning we find reports in the papers regarding the action which has been brought by W. Fargo & Co. against B. In our last letter we called your attention to the sulphuric acid smell and the hissing of the two cases that were opened in the warehouses of the Pacific Railroad, and we shall be glad to hear from you about this. To-day we have to add that we put the first case of oil into champagne bottles, and stored these in the house where the other cases were.

We have been compelled to take them away from there, and have not been able to find any place for them yet; everywhere, even in islands in the bay, people refuse to store them, as everyone is terrified of the article, and won't have the chest near them at any price. Herr Nielsen and some Chinamen have put the chests into a small boat, and have anchored her with some of the champagne bottles about five miles from the town. What can this mean, unless it is that the oil is beginning to decompose. If this process of decomposition continues unchecked, would it not be possible for spontaneous combustion to ensue, although some time

may elapse before the oil becomes dangerous. When would such danger occur, or would it never occur? Why was it that the first case, on being opened, gave off practically no odour at all, while the other two cases had a coppery smell, and why did the oil make a sizzling noise when the cork was drawn? These are important questions for us, and we should be glad if you would answer them.

Up to now the cases have been stored in a small wooden shed about three miles from the town (about five hundred yards from some powder sheds). We have recently had some very hot days, such as occasionally occur at this time of the year. The temperature in the open air was about 80 degrees Fahrenheit in the shade, and therefore about 100 degrees in the shed. If not more. May this be damaging to the oil?

The two cases, and the bottles, which we opened, showed the peculiarities which we have mentioned before this recent hot weather. A question that arises is, how did the cases, and especially the one that was filled over there, get leaky? Of the cases sent to us, one zinc case arrived here almost empty, and we also heard that three of the cases were leaking at Panama, where they were repaired. Does the oil, in passing through the tropical heat at Aspinwall, Panama, expand so much that it bursts the cases, or is the soldering imperfect? The general opinion here is that zinc is not the right material to hold oil safely, and that neither is gutta-percha, for it is said that this substance cracks on passing from a tropical into a cool climate. If the cases had not leaked, no accident would probably have occurred yet. You no doubt are aware that tropical heat may produce an entirely different effect from the same specific temperature. Is it not possible, then, that tropical heat may, in the course of time, cause a spontaneous explosion? We cannot store any more oil under water, as we have only salt water in the bay, and that would soon eat through the tins, as would fresh water too, in our opinion.

Kindly write to us as soon as possible, and explain to us the peculiarities of the oil which we have mentioned. Our town will, no doubt, adopt the same measures regarding the oil as New York has done. It is generally felt that the Glonoin oil must be made here. Have you made experiments with oil as old as the oil you have sent, must be now ? And have you observed similar peculiarities on opening the tins ? Does not the oil become dangerous under such conditions ? In any case, do come here ; there is the greatest field in the world here for your Glonoin oil, and you alone can restore confidence. Have you ever seen mines in which three hundred to seven hundred kegs of gunpowder are exploded at once ? We have such mines, and call them " hydraulic mines." Mountains which are saturated with gold are washed with water brought from high up in the mountains in a conduit pipe ; the rock is often too hard, and then a tunnel is made into which as much as seven hundred kegs, with twenty-five pounds of gunpowder the keg, are placed and exploded. This method, however, costs much time and money. Now an artesian well hole, of about four to five inches diameter, and about two hundred feet deep, filled with Glonoin, would result in an enormous saving of time and money. The " Central Pacific Railroad " alone consumes about 300 kegs of gunpowder a day. It is therefore worth while to introduce your oil. As explosive oil was not invented by a member of their profession, the chemists are doing their level best to paint its dangers in the most sinister light. Please come, and send us a telegram to say when.

We hope that B. (Bürstenbinder) won't be very troublesome. The evidence you gave on the 25th was printed in the paper here the following day.

Yours, etc.,

BANDMANN, NIELSEN & CO.

APPENDIX IX

(*See page* 111)

NITRO-GLYCERINE REACHES THE FAR WEST

Letter from Julius Bandmann to Dr. B. in Hamburg.

San Francisco, Nov. 30, 1866.

MY DEAR DOCTOR,—

Since I last wrote to you, on the 19th instant, we have heard from Janson that the oil arrived safely at its destination. I hope that in a short time it will have been sold to various mining enterprises. As soon as the methyl-alcohol arrives here we will make any oil that we have on hand, innocuous.

In order to prove to you that decomposition had already set in in the oil here, in spite of anything Nobel may say to the contrary, I send you herewith a copy of the letter from the man who bought eleven cases from you, and the balance of whose consignment we made up. After we had opened various cases, and taken the tins out, he came up here the following day in a little boat, and with the help of another man, he packed all the tins in eleven cases, which he filled out with plaster of paris put round the tins, and then loaded his boat. Unfortunately it took him several days to reach Sacramento, as he had to fight against wind and current. The steamer which runs daily takes only about twelve hours for the journey.

Copy of letter from C. S. Swenson from the interior—Michigan Bluff—in Placer County, California.

Michigan Bluff, Nov. 21.

MESSRS. BANDMANN, NIELSEN & CO., etc.—

I got home (Michigan Bluff) as I advised you per telegram on the 10th after a long trip, having left San Francisco on the 7th.

We did not reach " Red rock " (island) before next day at 8 o'clock a.m., having passed the night in a schooner on the bay. We proceeded right off to repack the boxes, which work was done and the boxes in the boat at dark. One of the boxes which was in the lower tier close to the rock had nearly leaked out, and I left it on the island ; I should think this one and the one broken open will be about one tin full. There were five more which were rusty, and I could perceive that they had leaked a little, but I thought it best to take them along and get new tins in Sacramento and repack them there, which I did. I let the gas out of them all ; there was only one tin which had no gas in it (by boring a hole through the cork with a gimlet.—J. B.), and that tin was square, the others were bulged out on the sides like those which you saw. The boxes you and I opened in the sea water were quite rusty ; I therefore did not wet the remainder. While on the island I set off a blast in the manganese mine with about ½ Pfd. of oil ; it did very well and Mr. Moore, the foreman, declared his determination to use the oil for the future, and said " it was considerable out of his pocket, that he had not known how to use the oil before." I burned all the old boxes ; they made some noise, but there was no big explosion ; the flame close to the wood of the boards, that were saturated with oil, had the same colour as when nitric acid is poured on a substance of lead, iron and copper or boiling nitric acid fume. About the trip I will say, that under the circumstances it was as pleasant as could be expected, the two men were fine fellows, but the boat was too small for comfort, we had to pull the whole way, except from Benicia to Collinsville, and two days we were tied (in Schlepptou) to a schooner, the storm we had was too heavy. Later we borrowed a boat and towed to Sutterville, where we arrived in the afternoon on the 15th.

I started for Sacramento and found the team (horses and wagon) had been there since the 10th.

I also got five new cans and boxes, and Friday the team came to Sutterville with them ; we repacked the five boxes in the afternoon, loaded up and started next morning and got home as before stated without any accident, but with a great deal of jolting ; we drove very slow, as the roads were rather rough. On unloading we found that three more boxes had started leaking, but not to any considerable extent. I forgot to say that one can commenced leaking badly, the tin was good, but a little hole had been cut in the top about one inch from the side. The tins are very thin (yesterday on opening the boxes to take out the wooden pins [N.B. after letting out the gas I closed up the holes in the corks with little wooden pegs for the further transport. J. B.] on one the tube was buried in the plaster, and searching for it I put the screwdriver straight through the tin). Another of the boxes I found leaking very badly after I took it out, but the leaky side had been laying upwards. I have talked with my partners about the prices, and we all think it will not do to ask more than $2.50 per pound.

I took all the pins (from the corks) out again yesterday, and found there was just as much gas escaping as when I let the gas out on " Red rock " island (N.B. about 10 days ago. J. B.).

What effect it will have on the oil, God only knows, but I hope not for the worst.

At Sutterville I thought we had better burn the empty tins (5), so we made a fire of the wood from the empty boxes, the wood was somewhat wet—it had rained through the day—and the fire slow to start. I placed the tins on the pile, they would not lay very well as there were so many, and I was standing fixing them, not having the least idea that they would explode with that heat, when all at once an explosion took place with two tins that sent the tins about in great style, knocked out the fire and all. I got my hands to my ears in a hurry, not knowing for a while whether

I had any or not; and it was over two hours before my ears got quite straight again, no further accident happened. The oil was well drained out of the tins as they had been standing with the tube down for about three hours. I did not burn the other tins, but cut them in pieces and buried them in the ground. The report was as hard as that of a cannon. I don't know what to think of it or the oil, but don't think there could be 360 degrees of heat. (N.B. The man is very much mistaken here; first, it is exceedingly probable that there was still oil in the tins, even after they had been standing upside down for three hours, for if the tins were slightly bent, all the oil would not have run out; secondly, a temperature of 360 degrees might easily have been generated through the opening in the tins, as an ordinary flame is of the temperature of nearly a thousand degrees; and thirdly, the loud explosion is easily to be explained by the bursting of the empty tins. J. B.)

I would also like to know very much how old this oil is, and if it takes the same character of evolving gas at the same age in Europe? The heat don't seem to make any difference, as there was just as much gas in the tin at Red rock island as in the one I opened here which has been exposed to the severe summer heat on the works of the railroad.

I would like very much to know the address of Mr. Nobel (N.B. I gave him yours, letters to be sent through me. J. B.), so I could get him to write to the brother at home and let him know where the manufactories are located in Norway and Sweden and from that he can get into communication with the men in those countries and to them propound certain questions which I think would be a great help to parties interested in the use of the oil here and in particular to those interested in the manufactory here as from the observations of the miners and manufacturers together. We must get at the actual results of

the working, and if you could do the same in Germany it would be well.

Yours, etc.,

(Signed) S. C. SWENSON.

Decomposition must have been the cause of the gas given off when the tins were opened at various times, so that the whole question is how long can the process of decomposition proceed before the oil becomes dangerous. To determine this period will scarcely be possible. The fact that you have had oil for about six months in your office means nothing, for, first, our oil is already much more than six months old; secondly, your oil did not go through the tropics; and thirdly, it is probably not as closely confined as ours. Moreover, the fact that the tins bulged shows that a quantity of gas had collected in them.

Some days ago the Pacific Mail Steamship Company wrote to us to inform us that twenty small cases, ostensibly containing alcohol, had arrived at Aspinwall, and that they had not yet been sent on, as they were believed to contain nitro-glycerine, because they had been consigned to us, and were similar to the former oil cases. We informed the company that they had no ground for alarm, and told them what kind of alcohol it was. We were informed that the company had written to Aspinwall to say that the cases did in fact contain alcohol, and that they left it to the discretion of the people there to forward them or not. This foolish action of the company is exceedingly trying, as it delays the arrival of the alcohol by at least a month, and we risk not getting it at all.

As the factory in New York is not yet working, surely Nobel has the right to send another consignment of unexplosive oil, but only by sailing ship. This cannot but be of advantage to the New York company, for the more the article gets known here, the

better for the New York company, if there should be a lack of capital for building a factory. The tins, however, would have to be much stronger than the last ones. Those that we had made here were much thicker and stronger.

If tins with unexplosive oil leak, surely the alcohol evaporates? And then the oil is as dangerous as ever.

I have written to the company in New York, and asked them to let me know their terms, and an approximate estimate for building a factory.

Greetings to all at home.

Your affectionate brother,

JULIUS B.

APPENDIX X

(*See page* 118)

EXCERPTS FROM THE REPORT OF THE SELECT COMMITTEE ON EXPLOSIVE SUBSTANCES SUBMITTED TO THE HOUSE OF COMMONS IN JUNE, 1874

Evidence of Alfred Nobel

The Chairman (Sir John Hay): How long have you been manufacturing dynamite?

Nobel: Since the end of 1866; about eight years.

Chairman: How many dynamite factories have you now in operation?

Nobel: I have thirteen at present in operation, and I am putting up two more, which will make fifteen in all.

Chairman: Will you state in what countries those works are situated?

Nobel: There are three in Germany, two in America, one in England, or rather Scotland, one in Spain, one in Portugal, one in Sweden, one in Italy, one in Switzerland, and one in Norway.

Chairman: Are there other dynamite factories besides your own?

Nobel: Yes, there are in those countries where I have no patent; I believe there are some eight or nine such factories altogether.

Chairman: Have any accidents occurred in your own and other factories in the manufacture of dynamite?

Nobel: Yes; I count one accident for each 1,500 tons of dynamite manufactured.

Chairman : Are there any laws or regulations in foreign countries to guard against exudation ?

Nobel : There are no laws against it, but there are regulations which are certainly not favourable to the safety of dynamite. The Belgian inspector, not knowing its nature, imagined that it was continually giving off vapours ; he ordered that the boxes should be made with small holes, which was the very best means of promoting danger, because the rain water ran in and caused nitro-glycerine to ooze out. I am very happy to say that this caused no accident, but it was a very imprudent regulation. The Prussian Government have done another unwise thing, they have compelled us to put dynamite cartridge into tin cans, because nitro-glycerine was in tin cans. They did not know that dynamite was a solid substance ; they actually wrote regulations containing instructions to put dynamite into tin cans ; and all that came of not knowing and not investigating the material.

Chairman : You have mentioned that on one occasion a ton and a half exploded, but that no damage took place, because the place was surrounded by an embankment ?

Nobel : Yes, one and a half tons liquid nitro-glycerine, not dynamite.

Chairman : What caused the explosion ?

Nobel : People get extremely careless when they have dealt for a little time with these explosives. For instance, a chemist who the first time he makes nitro-glycerine in large quantities is almost frightened to death, a fortnight afterwards gets so careless as to expose himself to the utmost danger. In the case just referred to a leakage had taken place which was very easy to stop, but instead of doing that, or letting it proceed, the chemist sent for a hammer ; he wanted to hammer it tight himself. If he had done it himself he would certainly have succeeded ; at least I should have succeeded, but it took some time ere the hammer could be

brought, and meanwhile he ordered a workman to take up a large stone, and knocking with that he caused an explosion. Nitro-glycerine will not stand much knocking, it will stand it to some extent, but not between hard bodies. You can scarcely get nitro-glycerine to explode if you put it on wood and strike it heavily with a hammer; but if it is spread over iron, and an iron hammer falls upon it, a very slight blow will suffice to explode it.

Mr. Vivian: I think you discovered nitro-glycerine, did you not?

Nobel: No, I did not; but nitro-glycerine could not be used without certain means of ignition, which I discovered, and certain facilities for its manufactures; that is all I discovered.

Mr. Vivian: You discovered the method of using it practically by means of absorbents, did you not?

Nobel: Not only that, but first of all the ignition by means of a cap or gunpowder charge. Though nitro-glycerine has been known to explode accidentally, setting fire to it for practical purposes is not so very easy; it will stand a gunpowder charge, and the gunpowder charge will blow out, the nitro-glycerine being found in the bore-hole unexploded.

Mr. Vivian: At first, when nitro-glycerine was discovered there were a great many accidents, were there not?

Nobel: Yes; and that by comparison proves the safety of dynamite, for whilst nitro-glycerine with a small sale gave rise to many accidents, dynamite in spite of a large trade has caused none. There were three or four very serious accidents from nitro-glycerine; but before the nitro-glycerine Act was passed in England I had published in German papers that I refused to sell any nitro-glycerine; therefore, I had taken steps before the British Government took steps to stop the sale of it.

Mr. Vivian: Those accidents led to the passing of the Nitro-glycerine Act, did they not?

Nobel: Yes, but I had stopped the sale long before, and I was the only manufacturer of the article.

Mr. Vivian: Were these accidents, in your opinion, the sole cause why the Nitro-glycerine Act was passed?

Nobel: Yes, but no doubt if nitro-glycerine had continued to be used as an explosive substance we should have found means to make it perfectly safe in handling by not using metallic packing, and using some other precautions, but it was more easy to convert it into a solid. My objection to nitro-glycerine was less from the difficulty of carrying it than from its liquid state, which causes it to leak into the crevices of bore-holes, thus getting filtered into the rock, and causing accidents, difficult to prevent, that was my chief reason for going over to dynamite.

Mr. Vivian: You had given up the sale of nitro-glycerine before the Nitro-glycerine Act was passed?

Nobel: Yes, long before.

Mr. Vivian: Did you manufacture it?

Nobel: Yes, I manufactured it for the purpose of making dynamite.

Mr. Vivian: But not for itself?

Nobel: No; after the first serious accident was known which would be attributed to the real danger of the material, I stopped immediately. I could do no more.

APPENDIX XI

Geta bei Norköping (Sweden). 20.8.1884.

DEAR SIR,—

I have been travelling so much that I have not been able to answer your letter of the 7th instant before. The following are my answers to the four questions which you put:

1. I began to occupy myself with nitro-glycerine in 1862.

2. I began to manufacture it on a large scale towards the end of 1863.

3. In June, 1862, I succeeded for the first time (the experiment being carried out by my brother in St. Petersburg) in causing a charge of nitro-glycerine to explode under water, having surrounded the nitro-glycerine with a charge of gunpowder.

Towards the end of 1863 I succeeded in causing liquid nitro-glycerine to explode at will, with the assistance of a small charge of sporting powder (about 1 gramme). A little later I made use of a percussion cap of a fulminating acid salt, which was placed on the end of a fuse. This was the first step in the use of stronger detonators, to which I later had recourse for dynamite.

I actually invented dynamite in November, 1863, and in my patent dated January, 1864, I already put in a claim in respect of "nitrogen absorbed by very porous charcoal or some other very porous substance." But since the great danger involved in the transport of liquid nitro-glycerine was as yet unknown, I did not further concern myself with the improvements of dynamite, nor did I make any further effort in this direction until 1866. Nevertheless, I made the first dynamite cartridge (nitro-glycerine absorbed

by porous charcoal) in November, 1863, and caused it to explode in an iron pipe, which was shattered. The explosion was effected without a detonator.

4. I invented blasting gelatine in 1875. All the experiments and research work were carried out without the slightest mishap. I should add that as early as 1866 I had attempted to make nitro-glycerine gelatinous, although I did not succeed that time, in spite of the fact that I hit upon nearly exactly the same method, for I tried to dissolve trinitrated guncotton in nitro-glycerine, in which it is difficult to dissolve it. It is quite true that this problem did not seem very important to me at the time, and that I was actuated more by curiosity in those investigations than by any more practical interest.

Yours, etc.,

A. NOBEL.

I hope you will forgive this letter being somowhat disconnected. I am surrounded by people who are talking, and I have only a few minutes left before I leave here.

DESCRIPTIVE LIST OF ALFRED NOBEL'S ENGLISH PATENTS

APPARATUS *for measuring gas.* The part of the volume of gas which it is desired to measure, shall be passed through an enclosed space in the apparatus, which is partially filled with a suitable liquid such as water or alcohol. The gas then saturates itself to a certain definite degree with the vapour of the liquid over which it must pass. In order to increase the area of contact between the gas and the liquid, porous lengths of cotton wool or other suitable material may be suspended with their base in the liquid which they will absorb by capillary attraction, and thus offer a considerably larger area of contact between the gas and the liquid. By measuring or weighing the amount of liquid carried away by the stream of gas, *e.g.*, by reading an indicator registering the change in the level of the liquid in the apparatus, the total amount of gas that has streamed through may be calculated. In order to allow for the greater degree of saturation in the apparatus at higher temperatures, a quicksilver throttle-valve shall be attached which will diminish the flow of gas through the apparatus as the temperature rises.

This invention relates to an improved apparatus for measuring the quantity of water or other liquid which passes through a pipe. For this purpose, the pipe through which the water or other liquid is made to flow is provided at any suitable part of its length with a socket for the reception of an upright tube of glass or other transparent material; into this tube, which is furnished with a graduated scale, is inserted a rod of alabaster or

other substance which is to dissolve slowly in water. This rod rests at its lower extremity in the water pipe, and is therefore exposed to the action of the water which flows through it; as, therefore, the lower end of the rod of soluble material is dissolved away by the water, it will gradually descend and show upon the graduated scale above, the quantity of water that has acted upon it, and which has consequently passed through the pipe. A similar kind of apparatus may be used for measuring alcohol or other liquids, for which purpose the soluble rod must of course be composed of some material that will be acted upon in a suitable manner by the liquid to be measured.

Improvements in the Construction of Barometers or Instruments to Indicate Pressure; the object being to produce a portable barometer in a cheap form, which will indicate the variations in the pressure of the atmosphere with tolerable accuracy. A graduated glass tube is connected in its lower end with a box or chamber made of metal, glass, india-rubber or other elastic material, the whole forming an apparatus similar to a thermometer, which is partly filled with mercury and partly evacuated. Care should be taken to adjust the quantity of mercury and the length of the glass tube so that the lowest barometric pressure to which the apparatus may be exposed, as well as the highest, may be recorded. The tube is closed in its upper end.

Any increase in the atmospheric pressure, by reason of atmospheric changes, will cause the liquid to rise more or less in the indicating tube, and thus a portable barometer of great simplicity and not exceeding the size of ordinary thermometers may be produced.

In order to prevent changes of temperature from injuriously or materially affecting the accuracy of the indications of atmospheric pressure, the box or chamber must be constructed of such a form that it will present a large surface to the pressure of the

atmosphere, and yet not contain a large body of mercury in comparison to that contained in the indicating tube.

Another method of obviating this difficulty is by the employment of some liquid, the volume of which is not liable to be greatly affected by changes of temperature, such, for instance, as water or liquid more or less saturated with some salt.

Instruments of the construction above named may also be employed as manometers, with this difference, *viz.*, that the pressure is given within the instrument, and, consequently, instead of making a vacuum in the tube, as in barometers, a cock must be adapted for the purpose of giving access to compressed gas or air.

Improvements in the manufacture of gunpowder and blasting powder. The use of explosive liquid, *e.g.*, nitro-glycerine, ethyl, or methyl-nitrate, in addition to gunpowder, in order to increase the effectiveness of gunpowder. The amount added should be limited in quantity so that the powder retains its dry, granular character. Nitro-glycerine might to a certain extent take the place of the saltpetre, and by reason of its insolubility in water as well as of its un-hygroscopic nature, it might act as a protective covering for the saltpetre, whereby it would be possible to use nitrate of soda instead of kali-saltpetre.

Improvements in the manufacture of and mode of applying explosive compounds. The practical use of nitro-glycerine as an explosive may be achieved by making use of its property of exploding on being heated, or on being detonated by a detonating charge. Nitro-glycerine may be manufactured in the following ways. (1) By adding nitric acid from time to time in small quantities to a mixture of glycerine and sulphuric acid, afterwards pouring out the nitro-glycerine that has formed. (2) By adding the total amount of glycerine to a mixture of two parts of sulphuric and one of nitric acid, stirring the mixture quickly for a moment, and then rapidly pouring the resultant mixture into cold water. The use of nitro-

mannite and nitrate of urea as additional compounds to make nitro-glycerine cheaper to produce. The use of phosphoric acid instead of sulphuric acid in order to obtain a greater yield. The freezing out of nitro-glycerine from the residue acids by cooling the mixture down to 5 to 10 degrees centigrade.

An improved explosive and the method for detonating it.—Nitro-glycerine is mixed with a suitable non-explosive porous absorbent, *e.g.*, charcoal, silicious earth, paper, etc., whereby a substance similar to gunpowder is produced, which is called dynamite, which can be practically used more easily and with less danger than nitro-glycerine. This explosive, being less sensitive, requires the use of a specially powerful detonator, having a larger charge which is firmly sealed at the end of the fuse, or consisting of a special charge of gunpowder, which causes the dynamite to explode.

Explosive.—The addition of nitro-glycerine to a mixture of combustible materials which in themselves are not explosive, such as powdered saltpetre and charcoal, or some other substance which contains carbon or carbo-hydrates, *e.g.*, resin, sugar or starch. The nitro-glycerine forms a thin coat over each individual grain and causes the whole to explode if a fulminate of mercury detonator is used. By way of example: 70 per cent barium nitrate, 10 per cent resin or charcoal, and 20 per cent nitro-glycerine with or without the addition of sulphur.

Improvement in the manufacture of explosives.—The addition of small amounts of paraffin, ozokerite, stearin, naphthalin, or any similar substance which is solid at an ordinary temperature and is of a fatty nature, to explosive mixtures having a hygroscopic character. The result is to provide a protective coating of paraffin, etc., to the other ingredients, which coating prevents the absorption of water and the resulting risk of an exudation of nitro-glycerine, if that substance is present in the explosive.

Method for the production of sulphuric acid.—Instead of being

introduced into large lead chambers, sulphurous acid produced in the ordinary way is introduced into smaller lead chambers, where it is brought into contact with sulphuric acid, containing small quantities of nitric acid, nitrous acid, and hyponitrous acid. The nitric acid is kept constantly circulating in the chamber by means of a douching apparatus, which distributes the acid equally among the inflowing sulphurous acid. A smaller lead chamber is substituted for the tower also, in which chamber the sulphuric acid reconverts, by means of a similar douching apparatus, the hyponitrous acid which has been decomposed by the sulphurous acid. This apparatus would be cheaper, and would produce a greater yield of resulting acid than that hitherto in use.

Burners for lighting purposes.—The superheating of the air for supporting combustion before being applied to the flame, by utilising the heat of the burnt gas, by means of a double chimney in which the air for supporting combustion must pass through an internal tube, surrounded by the hot burnt gases in the outer tube.

The use of light-giving substances within the zone of combustion for intensifying the light given off.

The application of compressed air, or the adjustment of the mouthpiece of the gas in such a way that it will act as an injector for the air for supporting combustion.

The use of compressed air at a high temperature for gasifying liquid combustible material, by being blown through it and saturating itself with combustible gas.

Improved explosive (blasting gelatine, or gelatine dynamite).—The reduction of nitro-glycerine or other explosive liquids from their dangerous liquid state to a semi-solid consistency by incorporating with them another substance capable of gelatinising or thickening, *e.g.*, guncotton, with or without the use of solvents such as alcohol, nitro-benzol and similar substances. The manufacture of explosives from gelatinous nitro-glycerine alone, or with an admixture of salts

in order to lessen the sensitiveness or the strength of the explosive. The use of nitro-benzol or similar substance for lowering the freezing-point of nitro-glycerine.

Apparatus for vaporising liquids.—This consists of a coiled tube of copper, iron, steel or some other suitable material, a feeding pump for the introduction of the liquid to be gasified, and a heating apparatus for the application of the necessary heat, together with a condenser, if used for distilling liquid, or apparatus for containing the steam, if intended to supply the place of a boiler for a steam engine.

In order to reduce friction, the coiled tube should be tapered outwards towards the exit end of the bore, by which means the inventor hopes that the apparatus will also be less liable to explode.

The manufacture of explosives.—The mixing of rapid and slow explosives in various proportions in order to secure the rate of combustion suitable to the particular kind of weapon or blasting operation.

Container for hygroscopic explosives.—The container should be of a suitable shape and size, being made of zinc, tin, copper, glass, gutta-percha, or some other airtight material, and furnished with a lid coated with indiarubber, having a spring hinge, whereby the lid may be opened, but as soon as it is released, the container is hermetically sealed, and thereby the contents are protected from the dampness of the air.

The refining of molten iron.—Heated hydrogen gas, or superheated steam, is directed upon the molten iron, in the same way as by a Bessemer burner, in order to eliminate the sulphuric and phosphoric impurities.

Improvement in the manufacture of explosives.—The production of a more powerful effect in blasting operations by detonating compressed gunpowder with specially prepared detonators, rein-

forced with barium nitrate, or with a small cartridge of dynamite.

Apparatus for the production of steam and the distillation of liquids.—See No. 224 of 1879.

Apparatus for the concentration of acids.—Instead of an apparatus made of platinum or some other expensive metal that is impervious to acids, a tower is used consisting of cast-iron tubes of considerable diameter, which are placed one upon the other, and are filled with fragments of clay or layers of some substance impervious to acids such as clay or glass.

The tower, which is closed on top with a lid, provided with a runner for the weak acid, is built into an incinerator. The bottom portion of the tower is provided with a hollow floor with a platinum pipe for drawing off the finished acid. The gases used for combustion heat the cast-iron tubes, which radiate heat through the material filling the tower, over which the weak acid runs down. In this way the acid is concentrated on its passage down through the tower, and by this arrangement it corrodes the cast-iron less than, for instance, in the case of direct contact in concentrating vessels.

Improvement in the vaporisation and concentration of liquids.—The liquid is squirted in a fine spray into a tower or chamber, together with hot air, or the heated combustion gases from an oven. The more volatile portions of the liquid are given off in a gaseous state, and may be collected in a condensing apparatus. The more concentrated liquid remains in the chamber, and is drawn off to the foot of it. This principle may be applied to the concentration of sulphuric acid, by the use of the combustion gases of sulphur ovens.

Improvement in the manufacture of anhydrous sulphuric acid.—The sulphuric acid fumes are conducted over glacial phosphoric acid in a cylinder made of platinum, stoneware, or some other material impervious to acid, with the result that the anhydrous

sulphuric acid that forms distils over and may be drawn off in any convenient manner. The process becomes a continuous one by filling the top end of the cylinder with concentrated phosphoric acid, and drawing off the rarefied acid at the base, the latter being again converted by distillation, after adding a small amount of water, in order to separate any sulphuric acid with which it may have become mixed.

The handling of explosives.—The solution of nitro-glycerine in a non-volatile solvent, *e.g.*, common tar, the boiling point of which exceeds 200 degrees centigrade, in order to warm a substance that is not explodable. The nitro-glycerine is restored in a form suitable for explosive operations, by adding a liquid such as oleic acid, which will dissolve tar, but in which nitro-glycerine is not soluble.

Receptacle for hygroscopic explosives.—This consists of a cardboard box, impregnated with paraffin, with a hermetically closing lid of the same material, which is fitted to one of the edges of the cardboard box, by means of a strip of glued cloth, and is provided with a spring contrivance, or a piece of elastic indiarubber to effect the automatic closing of the lid.

The same contrivance as No. 9022.—There are no particulars in the patent records.

The manufacture and use of explosives.—There is no description of these inventions.

A method of blasting rock by heat.—There is no description of this invention.

Manufacture of explosives.—Mononitro-benzol or dinitro-benzol, tar, camphor, or some other combustible liquid, soluble in nitroglycerine, is added as a substitute for pulverised salts, in order to reduce the explosive's sensitiveness to shock, as well as to lower the freezing-point and increase the stability. The application of this invention both to explosives for charging shells, and also to explosives to blasting operations.

Manufacture of explosives.—An explosive consisting of nitroglycerine mixed with nitrate, chlorate, or perchlorate, without the addition of combustible substances. 1

Six provisional patents that were not taken up.

Method for the manufacture and use of explosives.

Projectiles. Means for lessening the recoil in firearms.

Explosives. Improvements in fuses.

A new method for blasting rocks by heat.—See No. 14053, 1885. 1

Improvement in explosives and their use, especially in shells and torpedoes.—Projectiles or torpedoes are charged with solid, liquid or gaseous combustible substances, strongly compressed gaseous oxidising matter being introduced afterwards in a proportion adjusted to complete combustion. A special fuse arrangement, devised to prevent the premature firing of the main charge by the powder thread in the time-fuse.

The regulation of pressure in guns.—The invention consists of a piston valve with a spring contrivance, the object of which is to allow the gases to escape from the explosion chamber of the gun, if the pressure should reach a strength dangerous to the structure of the gun. The contrivance closes automatically as soon as the pressure has fallen to an amount consistent with the safety of the gun, so that the escape of gas need not prejudice the speed of the projectile.

Firearms and projectiles.—The bore is made of a conical shape, the diameter at the muzzle being less than at the breach-end (choke-bore). The projectile is made of a material sufficiently soft to adjust itself to the narrowing bore. The projectile may consist of three parts of different weights, separated by strips of cardboard, whereby the useful trajectory of their collective action will be wider.

Two provisional patents not proceeded with.

Explosive. Projectiles.

Contrivance for neutralising the recoil in firearms.—To the end of the muzzle is fixed a small tube, whose front end is closed, but which communicates with the barrel. Into this tube a small charge of guncotton or some similar explosive is inserted, this charge being ignited by the flame from the charge in the cartridge, as the bullet passes the communicating channel between the barrel and the tube in question. The explosion of the charge in the tube produces a recoil opposite to that produced by the cartridge, the two recoils neutralising one another.

Two provisional patents not proceeded with.

Explosive. Fuses.

Improvement in explosive shells.—A special fuse is introduced from the nose of the shell into the main charge, consisting of a steel tube containing powder, which is fired by the impact of the shell, and in turn causes the main charge to explode. By suitably adjusting the charge in the fuse, the main explosion can be delayed to meet any requirements, *e.g.*, in order to give the shell time first to pierce protective armour of varying thickness.

Improved detonators.—The detonating charge consists of collodion cotton, dissolved in acetone, with the addition of nitro-glycerine, and finely ground picrate of potash and chlorate of potash, which mixture, after the evaporation of the acetone, is ground into minute grains, about three thousand to ten thousand grains per gramme. The charge is fitted into pear-shaped or bottle-shaped cases built for the purpose, with a neck narrowed to fit the fuse. For military purposes, when more powerful detonation is required, the charge may be increased in amount, and an ordinary fulminate of mercury cap with half a gramme of fulminate inserted.

Safety explosive.—This contains copper ammonium nitrate, with a very strong detonator to discharge it. It is principally designed for use in mines containing coal-dust or other explosive mine gases.

It is not dangerous when lit. The use of the same double salt for firearms with a small amount of powder as a detonating charge.

Explosive.—Process for the manufacture of powder with nitrate of barium instead of saltpetre. A certain quantity of picrate of ammonia or amorphous phosphorus being added in order to overcome the sluggishness of the nitrate of barium powder.

Improvement in the manufacture of fuses.—The use of nitro-glycerine, which by means of guncotton is thickened and congealed with camphor, with an addition of finely ground salt, such as chlorate, perchlorate, nitrate, permanganate, and similar salts. The production of this substance which is impervious to water in cords for the manufacture of fuses. They would be used instead of the ordinary gunpowder fuses.

Improvement in the manufacture of explosives.—(Smokeless powder, ballistite.) The production of a gelatinous mixture consisting of nitro-glycerine and soluble nitro-cellulose in proportions varying between 1:2 and 2:1, with the assistance of a suitable solvent which can then be eliminated and reserved for further use. The treatment of the powder with warm rollers in order to achieve complete homogeneity. It is rolled out into thin sheets, which are cut with a knife or scissors into the desired shape and size. The use of nitrated starch or nitro-dextrin as a partial substitute for the nitro-cellulose, and the addition of a pulverised chlorate or picrate in various proportions.

Improved explosive.—The use of nitro-cellulose as an addition to explosives of nitrated starch or dextrin, together with a common solvent which is then separated and used again, with the object of preventing this explosive, which is otherwise brittle, suffering from friction, and also of preventing such unintentional changes in its explosive qualities as might thereby ensue. Before separating the solvent, the necessary amount of salts rich in oxygen are added in order to ensure the complete combustion of the finished explosive.

Improvement in cartridges.—Provisional patent regarding which no data are available.

Safety device against fires in buildings.—Provisional patent regarding which no data are available.

Improved explosive.—A process for increasing the quickness of granular ammonium nitrate explosive, by substituting picrate of ammonia for part of the nitrate of ammonia, with or without the addition of some other picrate such as picrate of potash, or copper ammonium picrate. Half per cent of gum arabic or some similar substance may be used to cause the mixture to cohere, the rest of the process being similar to the manufacture of gunpowder. Provisional patent regarding which no data are available.

Improved method for preventing fires and checking combustion.—By means of an apparatus which is already known the air in the room to be protected is saturated with water, in such a fine spray that the air loses its capacity for maintaining combustion.

A method for making explosives more serviceable.—Hygroscopic explosives (such as ammoniac powder) are preserved in cases of collodion or a soft celluloid, these being hermetically closed. The sacks or cases are made of thinly rolled sheets of the material in question, and the seams can be hermetically sealed by applying heat or by applying a collodion solution.

Improved manufacture of explosives.—(Supplementary patent to No. 1471, 1888.) Acetic ether of glycerine, or some similar non-volatile solvent, is used in the manufacture of smokeless powder, in order to produce explosives of determinate degrees of explosive sensitiveness. A method for producing cartridges containing such powder for use in mines. The firing of such charges by means of a fuse in order to get an effect similar to that produced by ordinary blasting powder when slow action is required, or by means of detonators if a shattering explosion is desired.

Improvement in the manufacture of explosives.—(Supplementary

patent to No. 1471, 1888.) A process for manufacturing a powder consisting of nitro-glycerine and soluble nitro-cellulose without the assistance of the solvents generally used hitherto, by using such nitro-cellulose as has the highest degree of solubility in nitro-glycerine. The powder is mixed in a wet condition with the amount of nitro-glycerine intended, in order to avoid its premature solution. As soon as the nitro-glycerine has been fully absorbed by the nitro-cellulose, it is heated to a temperature of 80 degrees, when gelatinisation takes place. It is then treated in the usual way with rollers and cutters. An alternative process consists in using nitro-glycerine in greater quantities than are required for the final product, in order to facilitate complete union with the nitro-cellulose. The surplus is removed either before gelatinisation, by separating it in presses, or after gelatinisation, by treating the finely rolled gelatine with 75 per cent of methyl-alcohol, in which nitro-glycerine is soluble, whereas nitro-cellulose is not. The addition of a benzol compound in order to lower the freezing point of nitro-glycerine so that the mixing process can be carried out at a temperature low enough to ensure against the possibility of the easily soluble nitro-cellulose becoming prematurely dissolved by nitro-glycerine.

Improvement in the manufacture and use of explosives.—(Supplementary patent to No. 1471 of 1888, and Nos. 4479 and 9361 of 1889.) This invention relates to the manufacture of cartridges and loading charges for guns, of smokeless powder, in the form of rolled, perforated, and corrugated sheets or plates, perforated cylinders or hollow caps, tubes or hollow sheaths, in order to provide as large a surface as possible for the action of combustion.

Improved cartridges and firearms for their use.—The construction of cartridges in which the bullet is either pushed in up to the firing device or, by the application of a steel plug in the centre, itself serves as an anvil for the firing pin when igniting the detonator.

The charge, which consists of nitro-glycerine powder rolled up, corrugated, or in some other convenient form, as described in patent No. 12307, 1889, surrounds the rear end of the bullet, like a casing, the front end of the bullet lying in the barrel. In this way the cartridge can be made very short or dispensed with entirely if the charge be adapted in shape to the breach-chamber and the bullet. In the latter case the mechanism is fitted with a packing contrivance to prevent the explosive gases from being blown out.

Three provisional patents:

Improvements in firearms.

Improvements in projectiles.

Improved construction of projectiles.

Improved firearms.—A method for preventing the overheating of the barrel in a machine-gun by surrounding them with a tubular cooling device into which water or some other suitable liquid may be poured.

Four provisional patents:

Improvement in the construction of rockets and the method of firing them.

A new method of constructing projectiles.

Projectiles for firearms.

Rockets and methods for firing them.

Improved method for generating gas at a high pressure for motive power purposes.—The production of hydrogen gas under pressure by continually adding to water or some other liquid containing oxygen and hydrogen, metallic sodium, potassium or pulverised magnesium in a suitable chamber to resist the pressure, and the use of the resulting hydrogen for driving propeller machines such as torpedoes, or for guiding balloons.

Two provisional patents, not proceeded with:

Projectile for firearms.

Rockets and means for firing them.

Improved method for effecting the evolution of gases under pressure, for obtaining motive power.—(Supplementary patent to No. 11212, 1891.) The action of sodium, potassium or kindred metals on water is modified by dissolving in the liquid substances such as ammonia that have little or no affinity with the reacting metals, but which are easily gasified by the heat resulting from the decomposition of the water, and thus increase the volume of gas and the pressure.

Eight provisional patents not further proceeded with:

Improvement in the manufacture of explosives.

Method for producing oxygen.

Rockets and method for firing them.

Method for the manufacture of cyanides.

Method for the production of nitrogen compounds.

Improvement in the production of nitrogen compounds.

Substitute for armoured plating.

Method for causing rockets and other projectiles to rotate.

Explosive.—(Supplementary patent to No. 1471, 1888.) The use of nitro-mannite instead of nitro-glycerine, together with nitrated cotton, with or without a solvent intended to form a permanent part of the compound, *e.g.*, dinitro-benzol.

Seven provisional patents not proceeded with:

Method for the manufacture and use of less violent explosives.

Process for manufacturing fuses.

Process for the production of nitrogen compounds.

Process for the manufacture of artificial silk.

Process for the soldering of metals.

Explosives.

Explosives.

Artificial rubber.—A process for the manufacture from nitrocellulose of substitutes for natural rubber, by the use of non-

volatile solvents, especially the nitro derivatives of hydrocarbons belonging to the benzol and naphthalene groups, in a liquid or solid state, or in both states together. In order to lessen the danger of combustion, if the product is to be used at higher temperatures, cellulose which is only slightly nitrated, or nitrated hydro- or oxy-cellulose may be used. The varying degrees of elasticity are achieved, partly by varying the nitro-cellulose content, and partly by varying the proportions of liquid and solid solvent used in the mixture.

Two provisional patents:

Improvements in firearms.

Improvement in the manufacture of artificial silk.

Improved fuse for mines and similar purposes.—(Supplementary to patent No. 1470, 1888.) In order to exclude the possibility of the powder core exploding instead of burning as it should, the sensitiveness of the powder mixture is reduced by a so-called tempering substance, *e.g.*, nitro-naphthaline, an oxidiser being mixed with it at the same time, such as chlorate of potash, or ferricyanide of potassium in suitable proportions, in order to ensure the needful regularity of combustion.

Improvements in phonographs and telephones.

Improvements in electric batteries.

The manufacture and use of modified explosives.

Artificial silk and substitutes for vegetable fibre.

Explosive.

Explosive.

Soldering of metals.

Process for increasing the consistency of metals.

Projectiles.

Improved process for the manufacture of artificial rubber, gutta-percha and leather, suitable for conversion into varnish.—Apart from the solvents of nitro-cellulose mentioned in patent No. 20234, 1893,

their chloro- and bromo- derivatives may be used for various purposes, *e.g.*, nitro-, chloro-, bromo-, chloro-nitro-, and bromo-nitro- derivatives of camphor, nitrated resins and resinous oils, the methyl, ethyl, and propylic ethers of oxalic, lactic, tartaric, etc., acids. From such compounds products are obtained having various qualities, thus from bromo-camphor we obtain a body with high insulating faculties, etc. By mixing finely powdered calcium carbonate or oxalate, barium sulphate or carbonate, or some similar substance, the sensitiveness of the product to combustion is reduced, without any noticeable change in its elasticity. By applying solvents of a suitable volatility, varnish for various purposes may be obtained.

Improvement in the forging of tubular metallic pieces.—A process for gradually increasing the diameter of the bore in firearms, by shooting through it at high speed a projectile of somewhat larger diameter until the bore of the firearm has attained the desired diameter, and the metal is tempered and reduced to normal temperature. The projectile, which is conical in shape, is fired from an accurately aimed cannon, and in order not unduly to strain the gun which is being subjected to treatment, the latter is heated to a dull red heat for sustaining the earlier shots. By the time the last shots are fired, when the desired diameter of the bore will have been nearly achieved, the metal may be of normal temperature. The rifling in the barrel may also be effected by this means, through firing projectiles, having ridges which will produce the necessary rifling in the barrel.

Improvement in gas check for explosives.—The ordinary driving ring surrounding the projectile is supplied with a small interior annular channel, communicating with a small powder charge, the charge exploding on firing the projectile, whereby a radial expansion of the ring takes place, with the result that the barrel is effectively filled, and the escape of explosive gases is prevented.

Improved cartridges, and firearms for them.—Provisional patent, not described.

Improved manufacture of armour plating.—Provisional patent, not described.

Improvement in the manufacture of incandescent burners.—Provisional patent, not described.

Process for increasing the temperature and brilliance of flames.—Provisional patent, not described.

Construction of priming tubes for projectiles.—The interior of the priming tube is divided into two separate chambers by a piston, which rests on one side against a projection in the interior of the tube, and on the other side against a pin placed in the centre. In the chamber in which the pin is, there is a detonator consisting of a charge of comparatively insensitive initial detonating material (*e.g.*, strongly compressed fulminate of mercury, nitro-mannite, or some similar substance). Surrounding the detonating charge is the principal priming, which consists of exceedingly insensitive explosive, *e.g.*, compressed picric acid. The chamber on the other side of the piston is filled with a charge of granular black powder, and is in communication with the percussion contrivance of the priming tube. On impact against the butt, the powder charge is fired, immediately, or by time fuse, driving the piston forcibly against the pin, with the result that the detonator, the main charge in the priming tube, and the projectile charge, are caused to explode.

7 *Improved method for the production of power.*—(Motive power.) Provisional patent, not described.

Improved explosive.—The reduction of the exploding temperature in explosives of the gunpowder type by substituting for the carbon, dextrine or some other substance which produces more gas and a lower temperature than carbon, as well as the addition of inert

components, such as sodium bicarbonate, which cool the explosive gases, in order to produce a safety explosive which may be used without danger in explosive coal gas or mining gas. A similar result may be obtained by the analagous treatment of ballistite, picric acid, etc.

Improved method for effecting earth or ground measurements by means of photographs.—A camera is attached to a balloon, rocket or projectile, and provided with a parachute, as well as with some suitable method for detaching the camera from its vehicle. By means of a separate contrivance the photographic plate is exposed at a certain height, and by means of enlargement, a representation of the desired size may be produced. 12. 5. 1 No. 10

Improvement in the method of working metal.—Provisional patent, not described. 1896 No.

Improvements in military rockets.—A contrivance in military rockets of similar projectiles for maintaining the initial velocity or increasing it, consisting of a receptacle, open at the rear, containing a set of rockets which, by means of time fuses, are fired at the appropriate moment, and through their combustion serve both to drive the projectile forward and to maintain or increase its rotary motion. 24. 6. 1 No. 14

Provisional patents, not described :

Improved motors. 1896 No.

Improved armour plating. 1896 No.

Improvement in the manufacture of artillery powder. 1896 No.

Improvement in the manufacture of artificial silk. 1896 No.

Improvement in the manufacture of artificial silk and other fibrous materials. 1896 No.

Improved manufacture of explosives (progressive powder).—The manufacture of smokeless powder having a slower rate of combus- 30. 11. No. 37

tion in its outer layer than in its inner layer, this being effected by pressing or rolling a more rapidly burning powder between two thinner sheets of a slower burning powder. The advantages consist in a greater density of the explosive material, a reduction of the maximum pressure on the explosion, and an increased effectiveness per unit of weight of the barrel.

15 *Improved rockets.*—Provisional patent, not described.

LIST OF THE NOBEL PRIZEWINNERS

I. THE NOBEL PRIZE FOR PHYSICS

The prize for the year 1901 was awarded to:

Röntgen, Wilhelm Conrad, professor of physics at the University of Munich, born 1845, died 10th February, 1923. In recognition of "the exceptional services rendered by him in the discovery of the special rays which have been called after him."

The prize for the year 1902 was divided equally between:

Lorentz, Hendrik Antoon, professor of physics at the University of Leyden, born 1853, died 5th February, 1928; and

Zeemann, Pieter, professor of physics at the University of Amsterdam, born 1865. In recognition of "the special services rendered by them in their investigations regarding the influence of magnetism upon the phenomena of radiation."

The prize for the year 1903 was divided equally between:

Becquerel, Henri Antoine, professor of physics at the Ecole Polytechnique, born 1852, died 25th August, 1908. In recognition of "the special services rendered by him in the discovery of spontaneous radioactivity." The other half was divided equally between:

Curie, Pierre, professor of physics at the *Ecole municipale de physique et de chimie industrielles* in Paris, born 1859, died 19th April, 1906; and his wife:

Curie, Marie Skledowska, professor at the *Ecole normale supérieure*

des jeunes filles in Sèvres, born 1867. In recognition of "the special services rendered by them in the work they jointly carried out in investigating the phenomena of radiation discovered by Professor Henri Becquerel."

The prize for the year 1904 was awarded to:

Rayleigh, Lord (John William Strutt), formerly professor of natural philosophy at the Royal Institution of Great Britain in London, born 1842, died 1st July, 1919; "for his investigations into the density of the most important gases, and for his discovery of argon in connection with these investigations."

The prize for the year 1905 was awarded to:

Lenard, Philipp, professor of physics at Kiel University, born 1862; "for his work in connection with cathode rays."

The prize for the year 1906 was awarded to:

Thomson, Joseph John, professor of experimental physics at the University of Cambridge, born 1856; "in recognition of the great services rendered by him in his theoretic and experimental investigations regarding the passage of electricity through gases."

The prize for the year 1907 was awarded to:

Michelson, Albert Abraham, professor of physics at the University of Chicago, born 1852; "for his optical instruments of precision, and the spectroscopic and metrologic investigations which he carried out by means of them."

The prize for the year 1908 was awarded to:

Lippmann, Gabriel, professor of physics at the University of Paris, born 1845, died 12th July, 1921; "for his method, based upon the phenomenon of interference for reproducing colours by photography."

The prize for the year 1909 was divided equally between:
Marconi, Guglielmo, born 1874; and
Braun, Ferdinand, professor of physics at the University of Strasbourg, born 1850, died 20th April, 1918; "in recognition of their services in the development of wireless telegraphy."

The prize for the year 1910 was awarded to:
van der Waals, Johannes Diederik, formerly professor of physics at the University of Amsterdam, born 1837, died 8th March, 1923; "for his work in connection with the equation of state for gases and liquids."

The prize for the year 1911 was awarded to:
Wien, Wilhem, professor of physics at the University of Würzburg, born 1864, died 31st August, 1928: "for his discoveries regarding the laws governing the radiation of heat."

The prize for the year 1912 was awarded to:
Dalén, Gustaf, chief engineer, Stockholm, born 1869; "for his discovery of automatic regulators, which can be used in conjunction with gas accumulators for lighting lighthouses and light buoys."

The prize for the year 1913 was awarded to:
Kamerlingh, Onnes Heike, professor at the University of Leiden, born 1853, died 21st February, 1926; "in recognition of his investigation into the properties of matter at low temperatures which led, amongst other things, to the production of liquid helium."

The prize for the year 1914 was awarded to:
von Laue, Max, professor at the University of Frankfort-on-Main, born 1879; "for his discovery of the defraction of Röntgen rays on passing through crystals."

The prize for the year 1915 was divided equally between:
Bragg, W. H., professor at the University of London, born 1862; and his son:
Bragg, W. L., professor at the Victoria University of Manchester, born 1890; "for their services in the analysis of crystal structure, by means of X-rays."

The prize for the year 1916 was allocated to the special fund for this group of prizes.

The prize for the year 1917 was awarded in 1918 to:
Barkla, Charles G., professor at the University of Edinburgh, born 1877; "for his discovery of the characteristic Röntgen radiation of the elements."

The prize for the year 1918 was awarded in 1919 to:
Planck, Max, professor at the University of Berlin, born 1858; "in recognition of the services rendered by him to the development of physics, by his discoveries in connection with the quantum theory."

The prize for the year 1919 was awarded to:
Stark, Johannes, professor at the University of Greifswald, born 1874; "for his discovery of the Doppler effect in Canal rays, and of the decomposition of spectrum lines in an electric field."

The prize for the year 1920 was awarded to:
Guillaume, Charles Edouard, Sèvres, born 1861; "in recognition of his services to the physics of precision, by his discovery of anomalies in nickel steel alloys."

The prize for the year 1921 was awarded in 1922 to:
Einstein, Albert, professor, Berlin, born 1879. The prize was

awarded to Einstein independently of such value as may be ultimately attached to his theories of relativity and gravity, if these are confirmed, "for his services to the theory of physics, and especially for his discovery of the law of the photo-electric effect."

The prize for the year 1922 was awarded to:

Bohr, Niels, professor of physics at the University of Copenhagen, born 1885; "for his services in the investigation of the structure of atoms, and of the radiation emanating from them."

The prize for the year 1923 was awarded to:

Millikan, Robert Andrews, professor at Pasadena (California), born 1886; "for his works on the elementary charge of electricity, and on photo-electric phenomena."

The prize for the year 1924 was awarded in 1925 to:

Siegbahn, Karl Manne Georg, professor of physics at the University of Upsala, born 1886; "for his discoveries and investigations in X-ray spectroscopy."

The prize for the year 1925 was divided equally in 1926 between:

Franck, James, professor of physics at the University of Göttingen, born 1882; and

Hertz, Gustav, professor of physics at the University of Halle, born 1887; "for their discovery of the laws governing the impact of an electron upon an atom."

The prize for the year 1926 was awarded to:

Perrin, Jean, professor of physical chemistry at the University of Paris, born 1870; "for his works on the discontinuous structure of matter, and especially for his discovery of the equilibrium of sedimentation."

The prize for the year 1927 was divided equally between:

Compton, Arthur Holly, professor of physics at the University of Chicago, born 1892; "for his discovery of the phenomenon known by his name"; and:

Wilson, Charles Thomson Rees, professor at the University of Cambridge, born 1869; "for the method discovered by him of perceiving by condensation of steam, the paths taken by electrically charged particles."

The prize for the year 1928 was reserved for the following year.

II. THE NOBEL PRIZE FOR CHEMISTRY

The prize for the year 1901 was awarded to:

van t'Hoff, Jacobus Henricus, professor of chemistry at the University of Berlin, born 1852, died 3rd March, 1911; "in recognition of his special services in connection with the discovery of the laws of chemical dynamics and osmotic pressure in solutions."

The prize for the year 1902 was awarded to:

Fischer, Emil, professor of chemistry at the University of Berlin, born 1852, died 15th July, 1919; "in recognition of his special services in connection with his synthetic experiments in the sugar and purin groups of substances."

The prize for the year 1903 was awarded to:

Arrhenius, Svante August, professor of physics at the Stockholm University, born 1859, died 2nd October, 1927; "in recognition of special services rendered by him to the development of chemistry by his electrolytic theory of dissociation."

The prize for the year 1904 was awarded to:

Ramsay, Sir William, professor of chemistry at University

College, London, born 1852, died 24th July, 1916; "in recognition of his services in the discovery of the inert gaseous elements in air, and the determination of their place in the periodic system."

The prize for the year 1905 was awarded to:

Von Baeyer, Adolph, professor of chemistry at the University of Munich, born 1835, died 20th August, 1917; "in recognition of his services in the development of organic chemistry and the chemical industry, through his work on organic dyes and hydro-aromatic combinations."

The prize for the year 1906 was awarded to:

Moissan, Henri, professor of chemistry at the University of Paris, born 1852, died 21st February, 1907; "in recognition of the great services rendered by him in his investigation and isolation of the element, fluorine, as well as by his introduction to the service of science of the electric furnace called after him."

The prize for the year 1907 was awarded to:

Buchner, Eduard, professor of chemistry at the Agricultural College in Berlin, born 1860, died 12th August, 1917; "in recognition of his investigations in biological chemistry and his discovery of cell-less fermentation."

The prize for the year 1908 was awarded to:

Rutherford, Ernest, professor of physics at the Victoria University, Manchester, born 1871; "for his investigations into the disintegration of elements, and the chemistry of radio-active substances."

The prize for the year 1909 was awarded to:

Ostwald, Wilhelm Emeritus, professor of physical chemistry at

the University of Leipzig, born 1853; "in recognition of his works on catalysis, as well as for his investigations into the fundamental principles governing chemical equilibrium and rates of reaction."

The prize for the year 1910 was awarded to:

Wallach, Otto, professor of chemistry at the University of Göttingen, born 1847; "in recognition of the services rendered by him to organic chemistry and the chemical industry, through his pioneer work in the field of alicyclic compounds."

The prize for the year 1911 was awarded to:

Curie, Marie Skledowska, professor of general physics at the University of Paris, born 1867; "in recognition of the services rendered by her to the development of chemistry, by her discovery of the elements radium and polonium, by her determination of the nature of radium, and isolation of it in a metallic state, and by her investigations into the compounds of this remarkable element."

The prize for the year 1912 was divided equally between:

Grignard, Victor, professor at the University of Nancy, born 1871; "for the so-called Grignard reagent, discovered by him, which in recent years has greatly advanced the progress of organic chemistry"; and

Sabatier, Paul, professor at the University of Toulouse, born 1854; "for his method of hydrogenating organic compounds in the presence of finely disintegrated metals, whereby the progress of organic chemistry has been greatly advanced in recent years."

The prize for the year 1913 was awarded to:

Werner, Alfred, professor at the University of Zurich, born 1866, died 15th November, 1919; "in recognition of his works on the

linking up of atoms within the molecule, whereby new light has been thrown upon older fields of research, and new fields have been opened up, especially within the realm of inorganic chemistry."

The prize for the year 1914 was awarded in 1915 to:

Richards, Theodore William, professor at Harvard University, Cambridge, Mass., born 1868, died 2nd April, 1928; "in recognition of his accurate determination of the atomic weight of a large number of chemical elements."

The prize for the year 1915 was awarded to:

Willstätter, Richard, professor at the University of Munich, born 1872; "for his researches into the colouring matter of plants, especially chlorophyll."

The prize for the year 1916 was allocated in 1917 to the special fund for this group of prizes.

The prize for the year 1917 was allocated in 1918 to the special fund for this group of prizes.

The prize for the year 1918 was awarded in 1919 to:

Haber, Fritz, Berlin-Dahlem, born 1868; "for the synthetic production of ammonia from its elements."

The prize for the year 1919 was allocated in 1920 to the special fund for this group of prizes.

The prize for the year 1920 was awarded in 1921 to:

Nernst, Walther, professor, Berlin, born 1864; "in recognition of his work in thermo-chemistry."

The prize for the year 1921 was awarded in 1922 to:

Soddy, Frederick, professor, Oxford, born 1877; "for his contributions to the chemical knowledge of radio-active substances, and his investigations into the origin and nature of isotopes."

The prize for the year 1922 was awarded to:

Aston, Francis William, doctor, Cambridge, born 1877; "for his discovery of a great number of isotopes in several non-radioactive elements, by means of his mass spectrograph, as well as for his discovery of the whole number rule."

The prize for the year 1923 was awarded to:

Pregl, Fritz, professor at the University of Graz, Austria, born 1869; "for the method of micro-analysis of organic substances discovered by him."

The prize for the year 1924 was allocated in 1925 to the special fund for this group of prizes.

The prize for the year 1925 was awarded in 1926 to:

Zsigmondy, Richard, professor of inorganic chemistry and the chemistry of colloids at the University of Göttingen, born 1865, died September 25th, 1929; "for his exposition of the heterogeneous nature of colloid solutions, and for the methods he used in that connection, which have become a determining factor in the modern chemistry of colloids."

The prize for the year 1926 was awarded to:

Svedberg, The, professor of physical chemistry at the University of Upsala, born 1884; "for his works on disperse systems."

The prize for the year 1927 was awarded in 1928 to:

Wieland, Heinrich, professor at the University of Munich, born 1877; "for his investigations into the constitution of the bile acids and kindred substances."

The prize for the year 1928 was awarded to:

Windaus, Adolf, professor at the University of Göttingen, born 1876; "for his services in the investigation of the constitution of the sterols and their connection with the vitamins."

III. THE NOBEL PRIZE FOR PHYSIOLOGY AND MEDICINE

The prize for the year 1901 was awarded to:

von Behring, Emil Adolf, professor of hygiene and medical history at the University of Marburg, Prussia, born 1854, died 31st March, 1917; "for his work on serum therapy against diphtheria."

The prize for the year 1902 was awarded to:

Ross, Sir Ronald, professor of tropical medicine at University College, Liverpool, born 1857; "for his work on malaria."

The prize for the year 1903 was awarded to:

Finsen, Niels Ryberg, professor, principal of the Light Institute at Copenhagen, born 1860, died 24th September, 1904; "in recognition of his treatment of disease, especially *lupus vulgaris*, with concentrated light rays."

The prize for the year 1904 was awarded to:

Pavlov, Ivan Petrovic, professor of physiology at the Military

Medical Academy in St. Petersburg, born 1849; "in recognition of his work on the physiology of digestion."

The prize for the year 1905 was awarded to:

Koch, Robert, professor, principal of the Institute for Infectious Diseases in Berlin, born 1843, died 28th May, 1910; "for his work on tuberculosis."

The prize for the year 1906 was divided equally between

Golgi, Camillo, professor of pathology at the University of Pavia, born 1843, died 21st January, 1926; and

Ramon y Cajal, Santiago, professor of histology, histo-chemistry and pathological anatomy at the University of Madrid, born 1852; "for their work on the structure of the nervous system."

The prize for the year 1907 was awarded to:

Lavaran, Charles Louis Alphonse, Chef de service honoraire at the Pasteur Institute in Paris, member of the Institut de France, born 1845, died 1922; "for his work on the part played by protozoa in the generation of disease."

The prize for the year 1908 was divided equally between:

Ehrlich, Paul, professor, Geh. Obermedizinalrat, director of the Royal Institute for Experimental Therapy at Frankfort on Main, born 1852, died 20th August, 1915; and

Mechnikov, Iliya, director at the Pasteur Institute in Paris, born 1845, died 15th July, 1916; "for their work on immunity."

The prize for the year 1909 was awarded to:

Kocher, Theodor, professor of surgery at the University of Berne, born 1841, died 27th July, 1917; "for his work on the physiology, pathology and surgery of the thyroid gland."

The prize for the year 1910 was awarded to:

Kossel, Albrecht, professor of physiology at the University of Heidelberg, Geheimrat, born 1853, died 5th July, 1927; "in recognition of his achievements in the chemistry of the cell, by his works on proteins, the nucleic substances included."

The prize for the year 1911 was awarded to:

Gullstrand, Allvar, professor of eye therapy at the University of Upsala, born 1862; "for his work on the dioptrics of the eye."

The prize for the year 1912 was awarded to:

Carrel, Alexis, doctor, member of the Rockefeller Institute for Medical Research, New York, born 1873; "for his work on vascular ligature and on the grafting of blood vessels and organs."

The prize for the year 1913 was awarded to:

Richet, Charles, professor of physiology at the University of Paris, born 1850; "for his work on anaphylaxy."

The prize for the year 1914 was awarded in 1915 to:

Barany, Robert, lecturer on otology at the University of Vienna, born 1876; "for his work on the physiology and pathology of the vestibular system."

The prize for the year 1915 was allocated in 1916 to the special fund for this group of prizes.

The prize for the year 1916 was allocated in 1917 to the special fund for this group of prizes.

The prize for the year 1917 was allocated in 1918 to the special fund for this group of prizes.

The prize for the year 1918 was allocated in 1919 to the special fund for this group of prizes.

The prize for the year 1919 was awarded in 1920 to:

Bordet, Jules, professor of bacteriology at the University of Brussels, born 1870; "for his discoveries in connection with immunity."

The prize for the year 1920 was awarded to:

Krogh, August, professor of zoo-physiology at the University of Copenhagen, born 1874; "for his discovery of the regulation of the motor mechanism of capillaries."

The prize for the year 1921 was allocated in 1922 to the special fund for this group of prizes.

The prize for the year 1922 was, in 1923, equally divided between:

Hill, Archibald Vivian, professor of physiology at University College, London, born 1886; "for his discovery relating to the heat-production of muscles"; and

Meyerhof, Otto, professor of physiology at the University of Kiel, born 1884; "for his discovery of the correlation between the consumption of oxygen and the production of lactic acid in the muscles."

The prize for the year 1923 was awarded jointly to:

Banting, Frederick Grant, professor, Toronto, Canada, born 1891; and

Macleod, John James Richard, professor of physiology at Toronto, born 1866; "for the discovery of insulin."

The prize for the year 1924 was awarded to:

Einthoven, Willem, professor of physiology at Leyden, born

1860, died 29th September, 1927; "for his discovery of the mechanism of the electrocardiogram, the significance of this discovery having been proved by the investigations of recent years."

The prize for the year 1925 was allocated in 1926 to the special fund for this group of prizes.

The prize for the year 1926 was awarded in 1927 to:

Fibiger, Johannes, professor of pathology at the University of Copenhagen, born 1867; "for his discovery of the Spiroptera carcinoma."

The prize for the year 1927 was awarded to:

Wagner-Jauregg, Julius, professor of psychiatry at the University of Vienna, born 1857; "for his discovery of the therapeutic value of malaria inoculation in the treatment of dementia paralytica."

The prize for the year 1928 was awarded to:

Nicolle, Charles, "for his work on typhus exanthematicus."

IV. THE NOBEL PRIZE FOR LITERATURE

The prize for the year 1901 was awarded to:

Sully Prudhomme, René François Armand, member of the French Academy, born 1839, died 7th September, 1907; "in recognition of his exceptional merit as a writer, as shown even in his later years; and especially of his poetry, which reveals a rare genius for the expression of lofty idealism and deep feeling in a perfect form."

The prize for the year 1902 was awarded to:

Mommsen, Theodor, professor of history at the University of Berlin, born 1817, died 1st November, 1903; "the greatest living master of historical narrative, in special recognition of his monumental Roman history."

The prize for the year 1903 was awarded to:

Björnson, Björnstjerne, born 1832, died 26th April, 1910; "in recognition of a noble devotion to poetic creation over a long period of years, distinguished by a rare purity of spirit and originality of conception."

The prize for the year 1904 was equally divided between:

Mistral, Frederi, born 1830, died 25th March, 1914; "in recognition of the fresh originality and true artistic genius of his poetry, which faithfully mirrors the native spirit of his people, and of his important work as a Provence philologist"; and

Echegaray, José, member of the Spanish Academy, born 1833, died 14th September, 1916; "in recognition of the brilliant and extensive literary work in which he has revived the great traditions of the Spanish drama on original and independent lines."

The prize for the year 1905 was awarded to:

Sienkiewicz, Henryk, born 1846, died 16th November, 1916; "for his great achievements as an epic writer."

The prize for the year 1906 was awarded to:

Carducci, Giosuè, professor of literary history at the University of Bologna, born 1835, died 16th February, 1907; "not only in recognition of his wide learning and critical research, but also as a tribute to the vitality and lyrical grace that distinguish his poetic masterpieces."

The prize for the year 1907 was awarded to:

Kipling, Rudyard, born 1865; "in consideration of the gift of observation, the original imagination and the forceful appreciation and descriptive power that distinguish the vital creations of this world famous author."

The prize for the year 1908 was awarded to:

Eucken, Rudolf, professor of philosophy at the University of Jena, born 1846, died 15th September, 1926; "in recognition of the vigour of thought, the keenness and range of perception with which he has prosecuted his profound search for truth, and developed in his numerous works an exposition of an ideal attitude to life."

The prize for the year 1909 was awarded to:

Lagerlöf, Selma, born 1858; "in appreciation of the wealth of imagination and the profoundly spiritual perception which is revealed by her poetry."

The prize for the year 1910 was awarded to:

Heyse, Paul, born 1830, died 2nd April, 1914; "as a tribute to the imaginative quality of his art, as revealed during a long period of work as a lyricist, dramatist, novelist, and writer of world famous stories."

The prize for the year 1911 was awarded to:

Maeterlinck, Maurice, born 1862; "in appreciation of his many-sided literary activities, and especially of his dramatic works, which are distinguished by a wealth of imagination and by a poetic fancy which, under the guise of legend, shows deep penetration, mysteriously reflecting the unrealised emotions of the reader."

The prize for the year 1912 was awarded to:

Hauptmann, Gerhart, born 1862; "in special recognition of the distinction and the wide range of his creative work in the realm of dramatic poetry."

The prize for the year 1913 was awarded to:

Rabindranath Tagore, born 1861; "in recognition of his profoundly sensitive, fresh and beautiful poetry, whereby he has, with consummate skill, introduced his poetic thought, in English guise, to the literature of the West."

The prize for the year 1914 was allocated in 1916 to the special fund for this group of prizes.

The prize for the year 1915 was awarded in 1916 to:

Rolland, Romain, born 1866; "as a tribute to the lofty idealism of his writings, and to the wide understanding of human nature springing from a profound sympathy, which they reveal."

The prize for the year 1916 was awarded to:

Heidenstam, Verner von, born 1859; "in recognition of his importance as representing a new epoch in Swedish literature."

The prize for the year 1917 was divided equally between:

Gjellerup, Karl, born 1857, died 13th October, 1919; "for his varied and rich poetry, which is inspired by lofty ideals"; and

Pontoppidan, Henrik, born 1857; "for his vital descriptions of present-day life in Denmark."

The prize for the year 1918 was allocated in 1919 to the fund for this group of prizes.

The prize for the year 1919 was awarded in 1920 to:

Spitteler, Carl, Switzerland, born 1845, died 29th December, 1924; "in appreciation especially of his powerful epic, 'Olympischer Frühling.'"

The prize for the year 1920 was awarded to:

Hamsun, Knut, Norway, born 1859; "for his monumental work, 'Markens gröde.'"

The prize for the year 1921 was awarded to:

Anatole France (Jacques Anatole Thibault), Paris, born 1844, died 13th October, 1924; "in recognition of his brilliant work as an author, which is characterised by nobility and vigour of style and by wide human sympathy, and is typical of the French genius."

The prize for the year 1922 was awarded to:

Benavente, Jacinto, dramatist, Madrid, born 1866; "for the happy manner in which he has carried on the honourable traditions of the Spanish drama."

The prize for the year 1923 was awarded to:

Yeats, William Butler, born 1865; "for his poetry, which is always inspired, and gives expression in a rigidly artistic form to the spirit of a people."

The prize for the year 1924 was awarded to:

Reymont, Vladislav St., born 1868, died 5th December, 1925; "for his great national epic, 'The Peasants.'"

The prize for the year 1925 was awarded to:

Shaw, George Bernard, London, born 1856; "for his literary work, which is characterised both by idealism and by humanity, and whose lively satire is frequently associated with peculiar poetic beauty."

The prize for the year 1926 was awarded in 1927 to:
Grazia Deledda, born 1875, Rome; "whose works are inspired by high ideals, in her descriptions of life on her native island, which are rendered with the vividness of a painter, and who has treated general human problems with depth and sympathy."

The prize for the year 1927 was awarded in 1928 to:
Bergson, Henri, Paris, born in 1859; "in recognition of his rich and life-giving ideas and resplendent art with which they have been presented."

The prize for the year 1928 was awarded to:
Undset, Sigrid, Oslo, born in 1882; "principally with regard to her powerful pictures of Northern life in the mediaeval times."

V. THE NOBEL PEACE PRIZE

The prize for the year 1901 was divided equally between:
Dunant, Henri, founder of the Red Cross, originator of the Geneva Convention, born 1828, died 30th October, 1910; and
Passy, Frederic, founder of the first French peace society, President of the *Société francaise d'arbitrage entre nations;* born 1822, died 12th June, 1912.

The prize for the year 1902 was divided equally between:
Ducommun, Elie, Honorary Secretary of the Bureau International Permanent de la Paix, Berne (Switzerland), born 1833, died 7th December, 1906; and
Gobat, Albert, Secretary General of the Interparliamentarian Bureau, later Hon. Sec. of the Bureau International Permanent de la Paix, Berne, born 1843, died 16th March, 1914.

The prize for the year 1903 was awarded to:

Cremer, Sir William Randal, Member of Parliament, Founder and Secretary of the International Arbitration League, born 1828, died 22nd July, 1908.

The prize for the year 1904 was awarded to:

Institut de Droit International, a scientific society founded 1873 in Ghent (Belgium).

The prize for the year 1905 was awarded to:

von Suttner, Bertha, Baroness, Austrian writer, born 1843, died 21st June, 1914.

The prize for the year 1906 was awarded to:

Roosevelt, Theodore, President of the United States, born 1858, died 6th January, 1919.

The prize for the year 1907 was divided equally between:

Moneta, Ernesto Teodoro, President of the Lombard League of Peace, born 1833, died 10th February, 1918; and

Renault, Louis, Professor of International Law, at the University of Paris, born 1843, died 8th February, 1918.

The prize for the year 1908 was divided equally between:

Arnoldson, Klas Pontus, Swedish writer, at one time member of the Reichstag, born 1844, died 20th February, 1916; and

Bajer, Friedrik, Member of the Danish Parliament, Honorary President of the Bureau International Permanent de la Paix, Berne, born 1837, died 23rd January, 1922.

The prize for the year 1909 was divided equally between:

Beernaert, Auguste Marie François, Belgian Minister, Member of the Chamber of Representatives, Member of the Permanent Court of Arbitration at the Hague, born 1829, died 6th October, 1912; and

d'Estournelles de Constant de Rebecque, Paul Henri Benjamin Balluet, Baron, French Senator, Founder and President of the French Parliamentary Arbitration Committee, and of the League, "La Conciliation Internationale," Member of the Permanent Court of Arbitration at the Hague, born 1852, died 15th May, 1924.

The prize for the year 1910 was awarded to:

The Bureau International Permanent de la Paix, Berne, Switzerland, founded 1891.

The prize for the year 1911 was divided equally between:

Asser, Tobias Michael Carel, Dutch Minister and Member of the Privy Council, born 1838, died 29th July, 1913; and

Fried, Alfred Hermann, Austrian journalist, Editor of the *Friedens-Warte*, born 1864, died 4th May, 1921.

The prize for the year 1912 was awarded in 1913 to:

Root, Elihu, at one time Senator of the United States, formerly Secretary of State, born 1845.

The prize for the year 1913 was awarded to:

La Fontaine, Henri, Belgian Senator, President of the Bureau International de la Paix, Berne, born 1854.

The prize for the year 1914 was allocated in 1915 to the special fund for this group of prizes.

The prize for the year 1915 was allocated in 1916 to the special fund for this group of prizes.

The prize for the year 1916 was allocated in 1917 to the special fund for this group of prizes.

The prize for the year 1917 was awarded to:
Comité International de la Croix-Rouge, Geneva, founded 1915.

The prize for the year 1918 was allocated in 1919 to the special fund for this group of prizes.

The prize for the year 1919 was awarded in 1920 to:
Wilson, Woodrow, President of the United States, born 1856, died 3rd February, 1924.

The prize for the year 1920 was awarded to:
Bourgeois, Leon, President of the French Senate, and of the Council of the League of Nations, born 1851, died 29th September, 1925.

The prize for the year 1921 was equally divided between:
Branting, Karl Hjalmar, Minister of State, Stockholm, born 1860, died 24th February, 1925; and
Lange, Christian Lous, Secretary General of the Inter-Parliamentary Union, Geneva, born 1869.

The prize for the year 1922 was awarded to:
Nansen, Fridtjof, Professor, Oslo, born 1861.

The prize for the year 1923 was allocated in 1924 to the special fund for this group of prizes.

The prize for the year 1924 was allocated in 1925 to the special fund for this group of prizes.

The prize for the year 1925 was awarded in 1926, being equally divided between:

Chamberlain, Sir Austen, British Secretary of State for Foreign Affairs, born 1863; and

Dawes, Charles Gates, former Vice-President of the United States, born 1865.

The prize for the year 1926 was equally divided between:

Briand, Aristide, French Minister for Foreign Affairs, born 1862; and

Stresemann, Gustav, Minister for Foreign Affairs of the German Empire, born 1878, died 3rd October, 1929.

The prize for the year 1927 was equally divided between:

Buisson, Ferdinand, formerly Professor at the Sorbonne, Paris, born 1841; and

Quidde, Ludwig, Professor, Berlin, born 1858.

NOBEL PRIZEWINNERS

Arnoldson	P	1908
Arrhenius	Ch	1903
Asser	P	1911
Aston	Ch	1922
von Baeyer	Ch	1905
Bajer	P	1908
Banting	M	1923
Barany	M	1914
Barkla	Ph	1917
Becquerel	Ph	1903
Beernaert	P	1909
von Behring	M	1901
Benavente	L	1922
Bergson	L	1927
Björnson	L	1903
Bohr	Ph	1922
Bordet	M	1919
Bourgeois	P	1920
Bragg, W. H.	Ph	1915
Bragg, W. L.	Ph	1915
Branting	P	1921
Braun	Ph	1909
Briand	P	1926
Buchner	Ch	1907
Buisson	P	1927
Bureau international de la Paix	P	1910
Carducci	L	1906
Carrel	M	1912
Chamberlain	P	1925
Comité international de la Croix-Rouge	P	1917
Compton	Ph	1927
Cremer	P	1903
Curie, M.	Ph	1903
Curie, M.	Ch	1911
Curie, P.	Ph	1903
Dalén	Ph	1912
Dawes	P	1925
Ducommun	P	1902
Dunant	P	1901
Echegaray	L	1904
Ehrlich	M	1908
Einstein	Ph	1921
Einthoven	M	1924
Eucken	L	1908
d'Estournelles	P	1909
Fibiger	M	1926
Finsen	M	1903
Fischer	Ch	1902
France, Anatole	L	1921
Frank	Ph	1925

Fried	P	1911
Gjellerup	L	1917
Gobat	P	1902
Golgi	M	1906
Grazia Deledda	L	1926
Grignard	Ch	1912
Guillaume	Ph	1920
Gullstrand	M	1911
Haber	Ch	1919
Hamsun	L	1920
Hauptmann	L	1912
von Heidenstam	L	1916
Hertz	Ph	1925
Heyse	L	1910
Hill	M	1922
van t'Hoff	Ch	1901
Institut de droit international	P	1904
Kipling	L	1907
Koch	M	1905
Kocher	M	1909
Kossel	M	1910
Krogh	M	1920
La Fontaine	P	1913
Lagerlöf	L	1909
Lange	P.	1921
von Laue	Ph	1914
Laveran	M	1907
Lenard	Ph	1905
Lippmann	Ph	1908
Lorentz	Ph	1902
Macleod	M	1923
Maeterlinck	L	1911
Marconi	Ph	1909
Mechnikov	M	1908
Meyerhof	M	1922
Michelson	Ph	1907
Millikan	Ph	1923
Mistral	L	1904
Moissan	Ch	1906
Mommsen	L	1902
Moneta	P	1907
Nansen	P	1922
Nernst	Ch	1920
Nicolle	M	1928
Onnes	Ph	1913
Ostwald	Ch	1909
Passy	P	1901
Pavlov	M	1904
Perrin	Ph	1926
Planck	Ph	1918
Pontoppidan	L	1917
Pregl	Ch	1923
Quidde	P	1927

Ramon y Cajal	M	1906
Ramsay	Ch	1904
Rayleigh	Ph	1904
Renault	P	1907
Reymont	L	1924
Richards	Ch	1914
Richet	M	1913
Rolland	L	1915
Röntgen	Ph	1901
Roosevelt	P	1906
Root	P	1912
Ross	M	1902
Rutherford	Ch	1908
Sabatier	Ch	1912
Shaw	L	1925
Siegbahn	Ph	1924
Sienkiewicz	L	1905
Soddy	Ch	1921
Spitteler	L	1919
Stark	Ph	1919
Stresemann	P	1926
Sully Prudhomme	L	1901
Suttner	P	1905
Svedberg	Ch	1926
Tagore	L	1913
Thomson	Ph	1906
Undset	L	1928
van der Waals	Ph	1910
Wagner-Jauregg	M	1927
Wallach	Ch	1910
Werner	Ch	1913
Wieland	Ch	1927
Wien	Ph	1911
Willstätter	Ch	1915
Wilson, Ch.	Ph	1927
Wilson, W.	P	1919
Windaus	Ch	1928
Yeats	L	1923
Zeeman	Ph	1902
Zsigmondy	Ch	1925

Ch — Chemistry, P — Peace, L — Literature, M — Medicine, Ph — Physics.